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No. 55

U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF FORESTRY—BULLETIN No. 55.
GIFFORD PINCHOT, Forester.

FOREST CONDITIONS

OF

NORTHERN NEW HAMPSHIRE.

DEPARTMENT OF FORESTRY
COLORADO STATE COLLEGE
FORT COLLINS, COLORADO

BY

ALFRED K. CHITTENDEN, M. F.,
Assistant Forest Inspector, Bureau of Forestry.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

Copy 1.

MOUNT BOND, NEW HAMPSHIRE. CLEAR CUTTING ON THE UPPER SLOPES.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Forestry,
Washington, D. C., June 29, 1904.

Sir: I have the honor to transmit herewith a report entitled "Forest Conditions of Northern New Hampshire," by Alfred K. Chittenden, Assistant Forest Inspector in the Bureau of Forestry, and to recommend its publication as Bulletin No. 55 of the Bureau of Forestry.

The two maps and seven plates accompanying this bulletin are necessary for its proper illustration.

Very respectfully,

Gifford Pinchot,
Forester.

Hon. James Wilson,
Secretary of Agriculture.

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FOREST CONDITIONS OF NORTHERN NEW HAMPSHIRE.

INTRODUCTION.

Early in 1903 the legislature of New Hampshire passed the following resolution:

Resolved by the senate and house of representatives in general court convened, That the forestry commission be, and hereby is, authorized and directed to procure, upon terms to be approved by the governor and council, a general examination of the forest lands of the White Mountain region by employees of the Bureau of Forestry in the Department of Agriculture at Washington, whose report shall be laid before the next session of the general court; and the governor is hereby empowered to draw his warrant for a sum not exceeding five thousand dollars, upon any money in the treasury not otherwise appropriated, to meet the expense of such examination.

Approved, February 24, 1903.

The examination authorized by this resolution was begun in May of the same year and carried on during the summer months.

The lines of investigation followed were those laid down, after consultation with the State commission, in the following extract from a letter from the Secretary of Agriculture to the commission:

The specific purpose of this work will be to determine, by a thorough study on the ground, the conditions existing in the forest and the causes of those conditions, to estimate the cost and devise the methods necessary to the preservation of the forest of the White Mountain region and ultimately of the whole State, and to forecast the character and the value of its results.

The following lines of investigation commend themselves to me as the more important:

(1) A study of the composition and quality of the forest and an estimate of the present stand, results which would be used partly in the completion of the forest map of New Hampshire, published in 1894.

(2) A study of the characteristics of the more important trees and of the conditions necessary to their successful reproduction.

(3) A study of the methods and extent of lumbering, of its effect upon the forest, and of those modifications which are practicable in order to improve the condition of cut-over lands.

(4) An investigation of the value of the forest as a conserver of the water supply, in which I hope to obtain the assistance of the United States Geological Survey. This would include the determination of the size and condition of the watersheds tributary to large streams rising within the White Mountain region,

of the effect of forest destruction upon the flow of these streams, and of the value and amount of water power which is available at different seasons of the year or which is already in use.

(5) A study leading to a statement of the size, the value, and the character of the lumber industry of the State of New Hampshire.

The timber map which accompanies the present report presents a part of the results of these investigations. It covers the entire State north of Squam Lake as far west as the farm lands along the Connecticut River, embracing in all an area of 3,050 square miles, or 32 per cent of the total area of the State. This map shows the extent and present condition of the forest. It is as accurate as careful field work in the short time available could make it. It is not designed, however, to show the exact amount of timber on small areas, but rather the present condition of the forest throughout the region examined.

The study of forest fires, which are without doubt the greatest danger confronting the forests of New Hampshire to-day, was carried on with a view to devising some adequate system of fire protection for the State. Without efficient protection of the forest from fire, the attempt to carry on a conservative system of lumbering will fail all along the line, since both the commercial productiveness and the permanent preservation of the forest depends upon it.

The cooperation of the Division of Hydrography of the United States Geological Survey secured a careful study of the water supply of the region, a part of which has already been embodied in two reports submitted to the State forestry commission.

The study of the wood industries embodied in this bulletin was made by Mr. J. Girvin Peters, Forest Assistant in the Bureau of Forestry.

RÉSUMÉ OF CONCLUSIONS.

The conclusions and recommendations based upon the study of forest conditions in northern New Hampshire by the Bureau of Forestry are given in detail at the end of this report. They may be briefly summarized as follows:

(1) Unless the forests are effectively protected from fire, the value of northern New Hampshire both as a summer resort, now the source of an annual revenue of approximately $8,000,000, and as a source of timber supply, will be seriously affected.

(2) Safety from forest fires is impossible without the organization of a fire service. Detailed recommendations for this are made on page 96.

(3) Conservative lumbering under the supervision of trained foresters would pay the large lumber and pulp companies operating in northern New Hampshire better than the present method.

(4) The conservative management of farm woodlots is practicable and greatly to be desired.

(5) Forest planting upon denuded lands unsuited for agriculture promises good returns.

(6) There should be a chief fire warden, who should also be State forester, who should maintain a State forest nursery for the distribution at cost of forest seeds and seedlings, and should bring about by lectures and instruction on the ground a better management of forest lands within the State.

(7) Since an excellent opening exists for the creation of a forest reserve by the purchase of cut-over lands in the mountains, the adoption of a policy looking to this end is recommended.

THE REGION.

PHYSIOGRAPHY.

The territory covered by this report, and in it designated as northern New Hampshire, is that part of the State north of Squam Lake and west as far as the agricultural lands along the Connecticut River. It includes the northern portions of Grafton and Carroll counties and the whole of Coos County, and embraces in all a total area of 1,951,977 acres, or 32 per cent of the entire State. It contains the entire White Mountain region, and is drained by four large river systems, the Connecticut, the Pemigewasset, the Saco, and the Androscoggin, all of which have their origin within this region.

TOPOGRAPHY.

The White Mountain region occupies the southern and larger portion of this area. The country is very rough and rugged, broken up as it is into many short mountain ranges and deep, narrow valleys. The northern part of the area is flatter, and contains many lakes and low mountains with wide, rolling valleys between. The entire region is essentially a forest country. That the land is, for the most part, better suited to forest production than to agricultural use is evidenced by the thousands of acres of once cultivated land which have now largely come up to dense forests of second-growth spruce and pine. Where repeated fires have not kept back the young growth these give good promise for the future.

The White Mountains cover about 812,000 acres, or 42 per cent of the entire area examined, lying in northern Grafton and Carroll counties and southern Coos County. Seventy-four mountains reach a height of over 3,000 feet, and of these 11 are over 5,000 feet in height. The tallest, Mount Washington, rises to an altitude of 6,290 feet above the sea, and is among the tallest peaks east of the Mississippi River.

A characteristic of the topography is the great irregularity of arrangement of the mountains. With the exception of the Presidential Range, there are no long ranges. The greater number of peaks are in irregular groups or isolated. The three main ranges, the Pres-

idential, the Carter-Moriah, and the Franconia, have a general northeast and southwest direction. The first of these, which contains the tallest peaks of the region, is about 20 miles in length. The high peaks in Waterville and Albany and Mount Moosilauke, on the western border of the region, are isolated mountains.

The general base level varies from 700 to 1,500 feet elevation, and from this level the mountains rise, for the most part, very abruptly. The slopes are generally steep and the intervening valleys narrow and sloping, with occasional wide intervales. The intervales are flat, and the soil is deep and fertile, furnishing the best farming land in the region.

GEOLOGY.

During the Paleozoic, or tropical, period preceding the Ice Age it is probable that the White Mountain region was covered for the most part with forests of beech, basswood, buckeye, pepperidge, and cinnamon. This is indicated by the fact that fossils of these species are found at Brandon, Vt. Long before this period, however, the mountains had been formed. The bases are a porphyritic gneiss, possibly of the later Laurentian period, together with several groups of granite from the early Huronian, the whole having been forced to a high elevation by lateral pressure. The general direction of the ranges is northeast and southwest. The Paleozic period was succeeded by the Ice Age, or Cenozoic period, in which no vegetation could have endured. To this period, together with the atmospheric influences upon the mountains since that time, is due the formation of soils throughout the region.

The continental ice sheet advanced from the northwest, the highest mountains offering no barrier to its advance. By grinding the rocks it deposited over the mountains a layer of gravel and sand varying from a few feet to 30 feet or more in depth, and fertile because of the potash, which is essential to plant life and which is a constituent of gneiss and granite. This action is well illustrated on Mount Moosilauke. The great stretches of sand extending over Madison, Ossipee, and adjoining townships are a deposit of the Ice Age. On the Presidential Range large blocks of stone were carried from the northern slopes to the summits, covering the finer earth deposited earlier. As the continental sheet disappeared it seems to have left glaciers radiating from the mountains in all directions. These carried large bowlders with them, which now strew the ground thickly in places, and deposited at frequent intervals lateral and terminal moraines. The finer grinding of the glaciers has deposited the clays which occur in places, but the coarser deposits have rendered much of the land too rocky for agriculture.

One of these glaciers, from two to three thousand feet in thickness, swept the sides of Mounts Moosilauke and Ascutney, in the Connecti-

cut Valley. Other independent glaciers moved down the Pemigewasset and Androscoggin valleys, up the valley of the Peabody River, and down the Crawford Notch and the Saco Valley. The even slopes of the hills about the village of Jackson are composed of drift supposed to have come from the earlier sheet, while the bowlders deposited upon it are due to the later glacial action.

Throughout the mountains the glacial moraines across the valleys have caused many of the small lakes and ponds. These deposits, being often gravelly, have sometimes been broken through, letting out the water. In some cases this has taken place since the settlement of the country. The bogs and swamps bearing spruce, larch, and balsam have similar origin. Bogs rich in peat are not infrequent. Several bogs, however, owe their presence to dams made by beavers. Considerable areas of the higher summits are often covered with peat, which affords a foothold for the shallow roots of spruce and balsam.

Erosion has played an important part both in the formation and, particularly, in the removal of mountain soil on steep slopes. The decaying mosses and lichens soaked in water form an acid that disintegrates the rocks. Heat and frost aid the process. The Androscoggin Valley, for instance, for 2 miles below Gorham is filled with rocks and débris cracked off from the surrounding hills. The slides on so many of the mountains, as on Washington, Osceola, Carter, and Tripyramid, the recent fatal slide on Cherry Mountain, and that on Mount Willey in the early part of the last century, are another form of erosion. Erosion is constantly going on in the mountains, particularly on the high slopes where the timber has been removed by the prevailing method of clear cutting. Here the run-off is far more rapid, often laying bare the rocks and occasionally causing destructive floods below.

CLIMATE.

The climate of New Hampshire varies in no essential from that of the other New England States. The precipitation of approximately 40 inches is ample for all agricultural crops and forest trees suited to the climate. The humidity, averaging, at 8 o'clock readings, over 75 per cent of saturation throughout the year, is very high, although somewhat lower than at certain points on the New England coast. This high degree of humidity greatly conserves the moisture available for vegetative growth, since it checks very markedly both the direct evaporation of moisture from the soil and the excessive transpiration of vegetation in general. The amount of precipitation that falls as snow is very variable, the annual snowfall being not infrequently 40 per cent above or below the average.

The temperature is, on the whole, exceedingly favorable for all kinds of forest growth. It is not characterized by extreme variations of

heat and cold, although the winters are long. Late frosts in the spring and early frosts in the fall are to be reckoned with. They frequently do great damage to farm crops.

The following table shows the average monthly mean temperature and rainfall in this region, as shown by the records of the Weather Bureau:

TABLE I.—*Climate of northern New Hampshire.*

Month.	Average temperature.	Average precipitation.	Month.	Average temperature.	Average precipitation.
	° *F.*	*Inches.*		° *F.*	*Inches.*
January	16.0	2.96	July	67.2	3.68
February	17.4	3.58	August	65.0	3.95
March	26.4	3.18	September	57.2	3.12
April	40.7	2.07	October	45.6	2.91
May	53.9	3.15	November	32.2	3.65
June	63.8	3.74	December	21.0	2.93

DRAINAGE.

Of the four main streams which drain northern New Hampshire, the Connecticut, the Saco, the Pemigewasset, and the Androscoggin, two, the Saco and Pemigewasset, rise in the White Mountains. The Connecticut has its source in the lakes of the same name in the northern part of the State, and the Androscoggin is formed by the junction of the Magalloway and the outlet of Umbagog Lake, the lower of the large chain of lakes in Maine known as the Rangeley Lakes. Though the Androscoggin flows for some distance through the State, the principal source of its water is in Maine. (See Map II.)

The areas of these drainage basins in the territory examined are as follows:

	Acres.
Connecticut River	683,758
Saco River	444,435
Pemigewasset River	343,512
Androscoggin River	480,272
Total	1,951,977

Each of these main river basins is divided up into numerous smaller basins formed by their tributaries. New Hampshire is an excellently watered State. There are innumerable streams and small brooks, springs, ponds, and miniature lakes, as well as a number of larger ones, chief of which, within the section examined, are the Connecticut Lakes in the extreme northern part of the State. There are very few large areas of swamps; aside from a number of small bogs, the country is generally well drained.

OWNERSHIP OF THE LAND.

The greater part of the territory examined is forest land, owned for the most part by large lumber and paper companies. There are

also a large number of lumber companies holding comparatively small tracts, and a great deal of land is held in lots of 100 acres, more or less, by private owners.

The following is approximately the ownership of the area examined:

	Acres.
Large lumber and pulp companies	900,000
Hotel companies	28,000
Small holders of forest land	756,000
Agricultural land, small holdings	244,000

VALUE OF THE LAND.

Up to 1869 the State owned the greater part of the White Mountain region and Coos County. The policy of the State was to dispose of its public lands as fast as possible, and large tracts were sold for almost nothing. During recent times, however, the value of land has increased very rapidly, and now, owing to the growing scarcity of spruce in the State, good forest land commands an excellent price.

The best spruce land brings from $20 to $30 per acre, according to the stand and quality of the spruce and its accessibility for lumbering. The greater part of the country, however, is cut over, and much of it badly burned. Such land, with little or no merchantable spruce and covered with hardwoods, is worth from $2 to $4 per acre. Burned or abandoned land can be bought for from $1 to $2 per acre. Such land often has a good second growth of spruce and balsam. The best second-growth spruce land is rapidly increasing in value, and is being bought up by the large lumber and pulp companies.

CLASSIFICATION OF THE LAND.

Map I shows the area considered by this report classified as follows:

Spruce and balsam land:
- Ten thousand board feet and over per acre.
- Five thousand to 10,000 board feet per acre.
- Under 5,000 board feet per acre.

Pine land.

Hardwood land:
- Fifteen cords and over per acre.
- Under 15 cords per acre.

Waste land.

Agricultural land.

Barren land.

Burns.

SPRUCE AND BALSAM LAND.

This includes all merchantable stands of timber yielding over 1,000 board feet of softwoods other than pine per acre. The growth consists

chiefly of spruce, with balsam, hemlock, and pine in mixture, the last two occurring more or less scatteringly. Hardwoods, chiefly yellow and paper birch, sugar and red maple, popple, and beech, occur in softwood growth in varying proportion, generally predominating in stands averaging less than 5,000 board feet per acre of softwoods.

The reason for considering so small a stand of softwoods as 1,000 board feet per acre and actually classing it as softwood growth, when, as a matter of fact, the preponderance of growth is hardwoods, is to realize one of the chief objects of this report, namely, to obtain the total stand of softwoods in the region under consideration, which, as previously stated, is principally spruce.

For convenience and expediency in estimating, the softwood growth has been divided up into three classes, according as the yield is 10,000 board feet and over, from 5,000 to 10,000 board feet, or under 5,000 board feet per acre.

Ten thousand board feet and over per acre.—This includes the most extensive virgin stands of merchantable softwoods, chiefly spruce and balsam. There is very little cut-over land in this class. It is found usually below an elevation of 3,000 feet, and is almost entirely owned by a few large lumber and pulp companies.

Five thousand to 10,000 board feet per acre.—This class includes a large amount of cut-over land from which sawlogs only have been removed, and also considerable areas of virgin forest on the upper slopes, occurring in a zone above the best class of softwoods, and reaching an average altitude of about 3,700 feet. The virgin and cut-over areas of this class can generally be distinguished by their comparatively high or low elevations, although frequently the two areas are contiguous. Such instances are the result of the lower slopes, where the stand of spruce was originally very heavy, having been logged for sawlogs only, while the upper slopes, where the stand was not so good, remained untouched.

Under 5,000 board feet per acre.—This division includes all cut-over lands now averaging from 1,000 to 5,000 board feet per acre, and a certain amount of virgin land which forms a narrow belt on some of the upper slopes, immediately below the scrub growth. This division is largely represented in the valleys, which, easily accessible, have in some cases been logged several times. When this class occurs on the high mountain slopes it marks the limit of merchantable timber, and reaches an elevation of about 4,000 feet. On the cut-over areas hardwoods, as a rule, form the bulk of the stand; on the virgin areas balsam predominates over spruce. The area covered by virgin forest is, however, very limited.

PINE LAND.

This land is situated almost entirely in the southeastern portion of the territory examined. For the most part the stands are almost

pure white pine, though with a slight mixture of red pine, and, with the exception of a limited area near Intervale, are entirely second growth, which has come up chiefly on abandoned farms.

HARDWOOD LAND.

This has been separated into two divisions, viz, 15 cords and over per acre, and under 15 cords. A division of this sort is essential in order to distinguish between the better class and the very poor growth of hardwoods which comes in immediately after cutting and fires. As the one grades almost imperceptibly into the other, and as there is practically no pure virgin hardwood land in the region, no convenient basis other than that of yield can be found.

Fifteen cords and over per acre.—For the most part this division includes the large areas from which softwoods have been culled until less than 1,000 board feet remain, and those areas clean cut or burned sufficiently long ago for them to yield now at least 15 cords per acre. In the first case the growth consists of an open stand of mature hardwoods, chiefly yellow and paper birch, sugar maple, and beech, in varying mixture. The trees are old and of poor quality. In the second case the growth consists of a rather dense stand of popple, birch, maples, and beech, with often a little spruce in mixture.

Under this division is also included a small area, but nevertheless worth noting, of almost pure virgin hardwoods in the vicinity of Bartlett village.

Under 15 cords per acre.—This division includes practically all land burned over within the last twenty years, and land from which the timber has been clean cut. The predominating species are wild red cherry, popple, and birch. There is often considerable sugar and red maple and beech, the latter species increasing in proportion every year after cutting. This class is merely an earlier stage of the first class of hardwoods. Often on the higher slopes there is considerable spruce reproduction as well.

WASTE LAND.

This embraces those areas that produce an absolutely valueless growth, such, for instance, as that found on the poorer quality of abandoned land, unmerchantable swamps, and the scrubby growth on the high mountain slopes. On the map the abandoned land and the scrub growth may be distinguished by the relatively low and high situations they occupy. A considerable area in the southeastern townships covered with pitch pine is classed as waste land. The pine occurs in more or less open growth or in small groups, usually with a dense undergrowth of scrub oak. The scrub growth on the upper slopes consists of balsam, spruce, and yellow and paper birch, varying

in size from trees which just miss being merchantable to the prostrate shrub at timber line.

AGRICULTURAL LAND.

Practically all the accessible valley lands are given up to agriculture. The great bulk of the farm land lies along the southern and western borders of the region and along the lines of railway. The township of Colebrook is considered very superior farming land.

BARREN LAND.

This includes the rocky summits of many mountains above timber line, where less than one-third of the ground is covered with scrub growth. The most extensive area is on the crest of the Presidential Range (Pl. II, fig. 1).

BURNS.

Areas run over by fire were mapped to indicate whether the fire occurred in the year 1903 or previously. This distinction was made to show the extent of the forest fires which swept over New Hampshire in the spring immediately preceding the examination. Attention was also paid in the case of each burn to the growth which came up after the fire, and which, in every instance, is practically all hardwoods. On the map this is indicated by a hatched color, the color indicating the succeeding growth.

The burns of 1903 are distinguished on the map from previous burns by hatching unaccompanied by any color, no growth having yet manifested itself on the newly burned areas. Unfortunately, the map does not show the relative area of this year's burns in comparison with earlier ones, since a great part of the area burned last spring had been previously burned over, in some instances several times.

For the most part the fires have started upon and have been confined to cut-over land. The virgin forest is strikingly free from any trace of fire. The subject of forest fires is considered in detail in another part of this report.

AREA OF LAND OF EACH CLASS AND STAND OF TIMBER, BY DRAINAGE BASINS.

To secure a convenient basis for an estimate of the amount of land of the different classes and the stand of timber in the region, a subdivision of the entire area was made by drainage basins, under the following heads: Saco, Pemigewasset, Ammonoosuc, Israel and Upper Ammonoosuc, Androscoggin, Magalloway, and Upper Connecticut. Of these the Ammonoosuc, Israel and Upper Ammonoosuc, and Upper Connecticut are parts of the Connecticut drainage basin, while the Magalloway basin is that part of the basin of the Maine river of

the same name which lies in New Hampshire, and which is tributary to the Androscoggin. A detailed description of each of these drainage basins is made in another part of this report.

The area of land of each class in the whole region was carefully mapped. The estimate of timber was made by eye, checked from time to time by taking sample acres in various localities, 219 acres being measured in all. The estimated yield includes all trees 6 inches and over in diameter breasthigh. To obtain a definite figure for the best class of softwood land, that over 10,000 board feet, 52 acres of this type were measured in various places, from Waterville to northern Pittsburg. The average of these, allowing liberally for cull, was found to be 16,000 board feet per acre. Accordingly, this figure has been used in working up the estimate. No attempt has been made to distinguish between spruce and balsam. The latter forms from 1 to 20 per cent of the total yield, according to situation; probably 10 per cent would be a liberal average for all localities. In mapping the hardwoods, the division into classes of over and under 15 cords per acre was made rather to show the condition of the growth and the relative ages of the cuttings than as an estimate, although it serves the latter purpose as well. The pine was not estimated, as it is practically all second growth and usually not of merchantable size.

TABLE II.—*Areas and yields of northern New Hampshire drainage basins.*

Class of land.	Saco.	Pemigewasset.	Ammonoosuc.	Upper Ammonoosuc and Israel.	Androscoggin.	Magalloway.	Upper Connecticut.	Total.
Softwoods:	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
Under 5,000 board feet per acre	47,025	124,451	33,240	87,443	95,562	69,000	154,920	611,641
5,000 to 10,000 board feet per acre	47,931	36,430	20,596	24,717	86,129	36,320	42,880	295,003
Over 10,000 board feet per acre	5,786	30,274	4,004	2,571	5,673	25,360	9,280	82,948
Pine	32,216	256	.....	520	720	.....	1,040	34,752
Hardwoods:								
Under 15 cords per acre	39,067	17,886	14,428	10,987	68,977	800	10,440	162,585
Over 15 cords per acre	154,448	51,712	16,633	31,115	38,619	.....	.....	292,527
Agricultural land	44,409	40,422	29,571	16,356	24,678	1,320	87,280	244,036
Burns, 1903	11,658	6,351	13,831	36,221	10,314	200	5,680	84,255
Waste land	53,581	33,452	8,972	7,944	5,368	1,120	4,080	114,517
Barren land	1,420	717	1,264	585	1,992	.....	.....	5,978
Water	6,894	1,561	.....	2,040	6,280	1,840	5,120	23,735
Total	444,435	343,512	142,539	220,499	344,312	135,960	320,720	1,951,977
Yield of softwoods (million board feet)	546	1,007	285	402	928	816	780	4,764

From the table it will be seen that the yield of softwoods in northern New Hampshire is estimated at 4,764,000,000 board feet.

Better to illustrate the present forest conditions, the following table has been prepared, bringing out the relative areas of cut-over and virgin forest in this region:

TABLE III.—*Area of northern New Hampshire land and water.*

	Acres.
Virgin merchantable forest	200,000
Cut-over or culled land	1,363,711
Barren and waste land	120,495
Total forest land	1,684,206
Agricultural land	244,036
Water	23,735
Total	1,951,977

From this it will be seen that virgin forest forms only about 12 per cent of the total forest area examined.

DESCRIPTION OF THE FOREST.

FOREST CONDITIONS.

In the State of New Hampshire as a whole two broadly distinguished types of forest occur. On the basis of these types the State divides itself into what may for convenience be called the northern and the southern divisions. Strictly speaking, these terms are not entirely accurate, for elevation quite as much as latitude laid down the boundary between them; on the east and west the southern division extends up the lowlands as far as the Saco and Ammonoosuc rivers, respectively, while the northern includes, in addition to Coos County, the whole of the White Mountain region, extending as far south as the towns of Waterville and Albany. The original forest of the southern division was mainly hardwoods and pine with the hardwoods preponderating, a preponderance which the early lumbering of the pine has largely increased. Both white pine and hemlock, however, are more abundant here at the present time than farther north. But hardwoods are the characteristic species.

Originally the entire northern division was covered with a dense forest of conifers. It was primarily a spruce country, and the spruce here attained fine dimensions. White pine, too, covered large areas and was mixed with spruce over much of the region. Balsam occurred in mixture on the upper slopes and in the lower, moister localities. There was originally very little pure hardwood forest in the northern part of the State, where it was confined to the lower slopes, with spruce in mixture.

The best spruce grew on hardwood land, where the soil is deeper and richer than on the steeper slopes. These lower slopes were, moreover, most easy of access to the lumberman, and in consequence were among the first to be cut after the land in the valleys had been lumbered. Owing to the presence of the hardwoods in mixture on these slopes, the growth that came up after lumbering was not spruce or balsam, but hardwoods. When fire has once run over such a slope

after lumbering, the growth of sprouts that comes in is very dense, and the character of the forest is materially changed.

The most characteristic trees of the northern division are the red and white spruce, balsam, sugar maple, beech, and white cedar.

In the region examined the southern division takes on somewhat the character of a transition zone between the northern and southern parts of the State. Some of the southern species, like the white and red oaks, here reach their northern limits, and mingle with those more characteristic of the north. But the hardwoods still remain dominant. Of typical northern trees, the white spruce and cedar do not occur in the south.

In the White Mountain region red spruce and balsam are the prevailing species, and reach the highest elevations on the mountains. North of the White Mountains, these trees with white cedar, and, around the Connecticut lakes, with white spruce, are the chief conifers. Lumbering has brought about a great change in the species. Hemlock and white pine, once common at low elevations and along the valleys, are now of but little importance in the forest. Of the hardwoods, yellow birch, sugar maple, and beech are the commonest, and have greatly increased in numbers on the cut-over land. But little of the original forest is now left. Where was formerly a heavy stand of spruce and balsam is now a hardwood forest with a little spruce in mixture. Where fires have occurred, there is a tangle of wild red cherry, yellow birch, and aspen (Pl. VII, fig. 1).

FOREST TYPES.

The original forest types of the region examined consisted of spruce flat, hardwood land, and spruce slopes. Of these the spruce slopes covered by far the greater part of the country. These types, while generally holding good, show considerable variation in different localities.

SPRUCE FLAT.

Spruce flats occur in the moister, lower situations, on the level or rolling land around lakes and streams and in the valleys. Spruce and balsam are the chief species, and on the wetter soils black spruce, white cedar, and larch are also common. There is often considerable yellow birch and red maple. Spruce does not form as good a timber tree on these flats as on higher ground. White pine and hemlock formerly occurred in great abundance on these low lands, but have been almost entirely cut out. Windfall is particularly common; exceptionally tall trees are very liable to be thrown.

Spruce flat is a very common type in New Hampshire, especially in the country north of the White Mountain district. Owing, however, to their accessibility, they have been almost entirely cut over, and but little virgin forest of this type now remains. Second growth on these flats is usually excellent, softwoods greatly predominating over the hardwoods.

The following table shows the average stand on this type in virgin forest in Coos County:

TABLE IV.—*Spruce flat—Pittsburg Township.*

[Average of 10 acres.]

Diameter breast-high.	Number of trees per acre.							
	Spruce.	Balsam.	Yellow birch.	Paper birch.	Sugar maple.	Black ash.	Mountain ash.	Mountain maple.
Inches.								
2	6.90	63.80	0.40	0.60			0.80	0.90
3	12.40	56.60	.90	1.70			.80	
4	12.50	41.00	.30	1.50		0.10	.60	
5	16.10	31.50	.70	5.00			.10	
6	14.30	18.60	.30	3.20				
7	14.90	19.20	.30	2.10				
8	17.30	15.80	.30	2.40				
9	16.40	9.00		2.30				
10	16.00	7.90	.40	1.40				
11	13.70	4.50		.70				
12	12.00	3.90	.10	.30				
13	10.10	1.10	.30	.80	0.10			
14	8.90	1.00	.40	.60				
15	7.50	.70	.40	.20				
16	6.50	.10	.20	.10				
17	5.50	.30	.20					
18	3.40		.20					
19	1.50		.30					
20	1.60		.20					
21	1.20		.10					
22	.40		.10					
23	.50							
24	.10							
25	.10							
35			.10					
Total	199.80	275.00	6.20	22.90	.10	.10	2.30	.90
Trees 10 inches and over.	89.00	19.50	3.00	4.10	.10			

HARDWOOD LAND.

On the lower slopes and deeper, better soils hardwoods form a large part of the growth. Here yellow birch, sugar maple, and beech are the characteristic trees, with considerable spruce in mixture. The spruce forms a better timber tree on these lower slopes than in any other situations.

These hardwood slopes rarely extend above an altitude of 2,400 feet. The forest is, as a rule, dense and clean, with a heavy shade. The ground cover consists chiefly of witch hobble, mountain maple, and mountain ash. The shade is too heavy for good softwood reproduction, but the hardwood reproduction, particularly sugar maple and beech, is often very thick, with a dense matting of small seedlings covering the ground. Very little of this type is now left in virgin forest, except in the upper part of the Magalloway watershed, since it was easily lumbered.

The following tables show the stand of this type in various parts of the State:

TABLE V.—*Hardwood land—Waterville Township.*

[Average of 50 acres.]

Diameter breast-high.	Number of trees per acre.										
	Spruce.	Balsam.	Hemlock.	Yellow birch.	Sugar maple.	Beech.	Paper birch.	Red maple.	Whiteash.	Mountain ash.	Other species.
Inches.											
2	26.44	5.48	0.18	4.48	3.98	14.08	.....	0.02	0.02	0.02	15.50
3	6.00	1.30	.08	1.48	.86	3.36	.....	.....	.....	.02	2.08
4	7.14	1.60	.14	2.22	.86	4.56	.....	.04	.....	.....	.56
5	6.00	.98	.18	2.68	.86	4.42	0.02	.06	.02	.....	.42
6	6.40	.52	.12	2.10	.50	3.72	.02	.12	.....	.....	.14
7	4.40	.34	.12	1.94	.62	2.82	.10	.02	.....	.....	.08
8	4.12	.10	.14	2.06	.54	3.36	.08	.....	.04	.02	.08
9	3.76	.14	.12	1.66	.36	3.36	.04	.....	.04	.....	.....
10	3.24	.02	.26	1.98	.44	3.28	.08	.08	.....	.....	.....
11	3.00	.10	.02	2.02	.52	3.36	.10	.08	.....	.....	.....
12	2.84	.06	.06	2.08	.58	3.76	.10	.08	.04	.....	.....
13	2.28	.02	.18	1.86	.66	3.72	.04	.04	.....	.....	.....
14	2.04	.....	.20	2.20	.64	4.26	.08	.02	.02	.....	.....
15	1.86	.02	.12	1.56	.32	3.38	.04	.....	.....	.....	.....
16	1.84	.....	.18	1.48	.56	2.36	.02	.02	.....	.....	.....
17	1.70	.....	.16	1.16	.50	1.74	.....	.06	.....	.....	.....
18	1.30	.....	.20	1.14	.36	1.74	.....	.02	.....	.....	.....
19	.62	.....	.12	1.10	.38	1.14	.....	.....	.02	.....	.....
20	.88	.....	.12	.82	.26	.98	.02	.02	.....	.....	.....
21	1.00	.....	.16	.84	.38	.70	.....	.....	.....	.....	.....
22	.62	.....	.14	.80	.42	.36	.....	.....	.....	.....	.....
23	.18	.....	.10	.88	.28	.04	.....	.....	.....	.....	.....
24	.20	.....	.16	.58	.30	.06	.....	.....	.....	.....	.....
25	.10	.....	.06	.30	.22	.04	.....	.....	.....	.....	.....
26	.04	.....	.12	.40	.20	.02	.....	.....	.....	.....	.....
27	.06	.....	.12	.18	.14	.....	.....	.....	.....	.....	.....
28	.04	.....	.....	.16	.14	.....	.....	.....	.....	.....	.....
29	.02	.....	.02	.12	.....	.....	.....	.....	.....	.....	.....
30	.....	.....	.10	.16	.04	.....	.....	.....	.....	.....	.....
31	.....	.....	.02	.08	.....	.....	.....	.....	.....	.....	.....
32	.....	.....	.04	.08	.02	.....	.....	.....	.....	.....	.....
33	.....	.....	.....	.02	.....	.....	.....	.....	.....	.....	.....
34	.....	.....	.....	.04	.....	.....	.....	.....	.....	.....	.....
35	.....	.....	.....	.02	.....	.....	.....	.....	.....	.....	.....
36	.....	.....	.02	.08	.....	.....	.....	.....	.....	.....	.....
37	.....	.....	.02	.02	.....	.....	.....	.....	.....	.....	.....
38	.....	.....	.....	.04	.....	.....	.....	.....	.....	.....	.....
39	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
41	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
42	.....	.....	.....	.02	.....	.....	.....	.....	.....	.....	.....
Total	88.12	10.68	3.78	40.84	15.94	70.62	.74	.68	.20	.06	18.86
Trees 10 inches and over.	23.86	0.22	2.70	22.22	7.36	30.94	0.48	0.42	0.08	.....	.....

TABLE VI.—*Hardwood land—Pittsburg Township.*

[Average of 12 acres.]

Diameter breast-high.	Number of trees per acre.									
	Spruce.	Balsam.	Yellow birch.	Sugar maple.	Beech.	Black ash.	Paper birch.	White ash.	White elm.	Other species.
Inches.										
2	2.58	7.00	1.25	10.67	0.33	0.17				2.83
3	2.00	11.50	2.00	8.17	.83	.33				1.08
4	2.42	14.83	1.33	10.00	1.33					
5	2.08	12.92	2.08	7.58	1.42	.33	0.08			
6	2.17	9.56	2.08	6.50	1.00	.17		0.08		
7	.92	5.42	2.17	5.67	1.17	.67				.08
8	1.67	4.50	1.50	6.06	1.00	.25	.17			
9	1.33	2.75	2.42	5.42	.92	.42				
10	1.67	2.08	1.83	6.25	.75	.08				
11	1.08	1.17	1.83	5.75	.17	.58				
12	1.00	.50	1.50	4.67	.08	.08	.08			
13	1.25	.17	2.00	4.00		.25				
14	1.00	.25	1.67	4.75	.17	.17	.08			
15	.75	.08	2.00	3.00	.08	.17				
16	.75		1.50	3.42		.08				
17	.58		1.33	3.17		.08				
18	.58		1.42	1.83		.08				
19	.25		1.25	1.58						
20	.33		1.50	1.33						
21	.25		.67	1.00						
22	.17		.92	.42						
23	.08		.75	.17						
24	.08		.33	.25					0.08	
25	.08		.33	.08						
26			.42							
27			.50							
28			.08							
29			.08							
30			.42							
35			.08							
Total	25.07	72.73	37.24	101.76	9.25	3.91	.41	.08	.08	3.99
Trees 10 inches and over.	9.90	4.25	22.41	41.67	1.25	1.57	.16		.08	

FIG. 1.—BARREN UPPER SLOPES OF THE PRESIDENTIAL RANGE, NEW HAMPSHIRE.

FIG. 2.—FIRST CONNECTICUT LAKE, NEW HAMPSHIRE. EFFECT OF CONSTANT FLOODING FOR STORAGE.

TABLE VII.—*Hardwood land—Low and Burbank grant.*

[Average of 5 acres.]

Diameter breast-high.	Number of trees per acre.									
	Spruce.	Balsam.	Hemlock.	Yellow birch.	Sugar maple.	Beech.	Paper birch.	Mountain maple.	Striped maple.	Other species.
Inches.										
2	17.60	10.40	0.80	23.00	18.40	10.00	.....	27.00	28.40	0.20
3	11.60	7.80	.80	11.80	6.40	6.20	0.20	15.40	14.80	.....
4	7.20	5.80	.60	7.40	5.80	5.60	.....	3.00	5.20	.80
5	6.00	4.00	.60	5.40	4.20	4.20	.....	.40	1.80	.20
6	6.80	1.60	.80	1.80	2.60	3.80	.20	.20	1.00	.40
7	6.60	.60	.60	1.80	1.40	3.20	.20	.....	.40	.20
8	3.80	.80	.60	1.40	.20	2.60	.....	.....	.....	.....
9	5.80	.60	.....	1.20	.80	3.60	.20	.....	.20	.....
10	3.80	1.00	.20	.80	.60	2.20	.....	.....	.....	.....
11	2.80	.20	1.00	.80	.....	2.60	.....	.....	.....	.....
12	4.00	.20	.....	.40	.40	2.20	.20	.....	.....	.....
13	2.20	.20	.40	1.20	.20	2.20	.....	.....	.....	.....
14	4.40	.....	.60	1.20	.80	1.40	.20	.....	.....	.....
15	2.20	.20	.20	.40	.40	1.20	.....	.....	.20	.20
16	2.20	.....	.20	.80	.20	3.20	.....	.....	.....	.....
17	3.80	.....	.20	1.60	.60	1.60	.....	.....	.....	.....
18	2.10	.....	.....	2.00	.....	.80	.....	.....	.....	.....
19	1.80	.....	.60	1.80	.20	.20	.....	.....	.20	.....
20	.60	.....	.....	.60	.20	.40	.....	.....	.....	.....
21	.20	.....	.....	.80	.....	.....	.20	.....	.....	.....
22	.40	.....	.20	1.60	.....	.....	.....	.....	.....	.....
23	.40	.....	.....	.80	.20	.....	.....	.....	.....	.....
24	.....	.....	.....	.....	.....	.....	.20	.....	.....	.....
25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
26	.60	.....	.....	.60	.20	.....	.....	.....	.....	.....
27	.....	.....	.20	.20	.....	.....	.....	.....	.....	.....
28	.....	.....	.....	1.00	.....	.....	.....	.....	.....	.....
29	.40	.....	.....	.....	.....	.....	.....	.....	.....	.....
30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
31	.....	.....	.20	.....	.....	.....	.....	.....	.....	.....
Total	97.30	33.40	8.80	70.40	43.80	57.20	1.60	46.00	52.20	2.00
Trees 10 inches and over.	31.90	1.80	4.00	16.60	4.00	18.00	.80	.....	.40	.20

SPRUCE SLOPE.

This type occurs on the steeper slopes where the soil is shallow and the hardwoods do not thrive so well. The principal species are spruce and balsam, in varying proportions, and yellow birch, changing often to paper birch on the upper slopes. This type merges on the upper side into unmerchantable spruce and balsam, and finally runs out into a scrubby growth near the summits.

The stand is usually dense. Where the forest has been undisturbed the ground cover is moss. The balsam reproduction is often very thick and the spruce reproduction generally fair.

Spruce slopes cover the greatest area of any of the forest types in

northern New Hampshire. Where these slopes are cut over, if fire is kept out, the softwoods return in the second growth. When fire runs over the ground after lumbering, in many cases the entire soil is burned and washed away and the process of return to forest conditions is very slow. In some cases, as on the Sugar Loaves, in the township of Carroll, it will never be complete (Pl. VI, fig. 1).

The following tables show the average stand on spruce slopes and on upper spruce slopes in various parts of the State:

TABLE VIII.—*Spruce slope—Waterville Township.*

[Average of 65 acres.]

Diameter breast-high.	Number of trees per acre.									
	Spruce.	Balsam.	Hemlock.	White pine.	Yellow birch.	Sugar maple.	Beech.	Paper birch.	Red maple.	Other species.
Inches.										
2	22.20	13.06	0.14	.....	3.52	0.42	0.65	0.19	0.12	1.86
3	15.51	5.89	.11	.....	4.28	.32	.40	.38	.15	.48
4	14.28	4.94	.15	.....	4.86	.12	.35	1.17	.26	.23
5	12.94	3.46	.32	.....	4.58	.23	.35	1.31	.20	.14
6	11.20	2.37	.23	.....	3.40	.22	.35	1.41	.17	.06
7	10.48	1.71	.14	.....	2.88	.15	.28	1.25	.29	.06
8	10.45	1.60	.23	.....	2.72	.17	.26	1.69	.14	.02
9	11.14	.97	.23	0.02	2.14	.20	.22	1.17	.23	.....
10	11.03	.65	.32	.02	2.46	.23	.31	1.18	.22	.....
11	10.29	.29	.28	.....	1.57	.17	.23	.85	.18	.....
12	10.38	.37	.11	.....	1.57	.09	.35	.54	.03	.02
13	9.12	.25	.11	.....	1.52	.09	.29	.35	.03	.....
14	9.22	.05	.17	.....	1.40	.20	.29	.25	.08	.....
15	7.52	.08	.06	.02	1.28	.09	.18	.14	.06	.....
16	7.89	.03	.15	.02	1.09	.06	.18	.09	.....	.....
17	5.80	.....	.12	.....	.86	.09	.09	.05	.....	.....
18	5.12	.....	.06	.....	.91	.....	.09	.05	.....	.....
19	3.40	.....	.08	.....	.75	.02	.02	.03	.....	.....
20	2.48	.02	.06	.....	.80	.03	.02	.02	.....	.....
21	2.34	.....	.08	.....	.68	.03	.....	.05	.....	.....
22	1.18	.....	.05	.....	.57	.02	.....	.02	.....	.....
23	.68	.....	.02	.02	.25	.02	.....	.....	.....	.....
24	.45	.....	.03	.....	.23	.02	.....	.....	.....	.....
25	.29	.....	.06	.....	.12	.....	.....	.....	.....	.....
26	.11	.....	.03	.....	.20	.....	.....	.....	.....	.....
27	.15	.....	.03	.....	.09	.....	.....	.....	.....	.....
28	.09	.....	.02	.....	.02	.....	.....	.....	.....	.....
29	.....	.....	.02	.....	.03	.....	.....	.....	.....	.....
30	.....	.....	.....	.....	.05	.....	.....	.....	.....	.....
31	.....	.....	.....	.....	.02	.....	.....	.....	.....	.....
32	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
33	.....	.....	.....	.....	.02	.....	.....	.....	.....	.....
34	.....	.....	.....	.....	.02	.....	.....	.....	.....	.....
35	.....	.....	.....	.....	.02	.....	.....	.....	.....	.....
40	.....	.....	.....	.....	.02	.....	.....	.....	.....	.....
Total	195.74	35.74	3.41	.10	44.93	2.99	4.91	12.19	2.16	2.87
Trees 10 inches and over.	87.54	1.74	1.86	.08	16.55	1.16	2.05	3.62	.60	.02

TABLE IX.—*Spruce slope—Presidential Range.*

[Average of 35¼ acres.]

Diameter breast-high.	Number of trees per acre.									
	Spruce.	Balsam.	Hemlock.	Yellow birch.	Paper birch.	Sugar maple.	Red maple.	Beech.	Mountain ash.	Other species.
Inches.										
2	24.72	46.72	0.45	2.87	0.68	0.19	0.34	.....	2.26	5.69
3	16.15	25.66	.49	3.77	1.40	.08	.08	.....	1.40	2.60
4	15.77	17.43	.64	2.87	1.74	.15	.....	.....	.60	.46
5	11.62	13.77	.26	3.09	2.23	.15	.04	.....	.53	.12
6	8.68	8.56	.37	1.61	1.52	.11	.....	0.03	.25	.06
7	6.25	6.70	.45	1.41	2.17	.06	.....	.....	.17	.03
8	7.35	5.01	.34	1.44	1.72	.06	.03	.....	.14	.....
9	7.04	3.72	.39	.99	1.46	.06	.....	.....	.....	.....
10	6.82	2.82	.34	.96	1.86	.....	.....	.03	.....	.....
11	6.70	1.52	.23	.96	.93	.....	.....	.06	.....	.....
12	6.42	1.04	.45	.62	1.04	.11	.....	.....	.....	.....
13	6.93	.82	.14	.70	.76	.....	.....	.....	.....	.....
14	6.85	.42	.11	.59	.45	.03	.....	.....	.....	.....
15	6.28	.31	.20	.51	.28	.....	.....	.....	.....	.....
16	6.00	.14	.20	.59	.25	.03	.....	.....	.....	.....
17	4.76	.14	.20	.54	.17	.....	.....	.....	.....	.....
18	4.39	.03	.03	.68	.20	.....	.....	.....	.....	.....
19	2.85	.....	.14	.34	.06	.....	.....	.....	.....	.....
20	2.99	.06	.17	.23	.....	.....	.....	.....	.....	.....
21	2.03	.....	.06	.23	.03	.....	.....	.....	.....	.....
22	1.80	.03	.....	.17	.....	.....	.....	.....	.....	.....
23	1.75	.....	.03	.14	.....	.....	.....	.....	.....	.....
24	.59	.....	.06	.14	.....	.....	.....	.....	.....	.....
25	.56	.....	.....	.06	.....	.....	.....	.....	.....	.....
26	.28	.....	.03	.03	.....	.....	.....	.....	.....	.....
27	.08	.....	.....	.03	.....	.....	.....	.....	.....	.....
28	.....	.....	.03	.06	.....	.....	.....	.....	.....	.....
29	.08	.....	.....	.06	.....	.....	.....	.....	.....	.....
30	.....	.....	.03	.....	.....	.....	.....	.....	.....	.....
31	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
32	.....	.....	.....	.03	.....	.....	.....	.....	.....	.....
33	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
34	.....	.....	.03	.03	.....	.....	.....	.....	.....	.....
Total.	165.74	134.90	5.87	25.75	18.95	1.03	.49	.12	5.35	8.96
Trees 10 inches and over.	68.16	7.33	2.48	7.70	6.03	.17	.....	.09	.....	.....

TABLE X.—*Spruce slope—Pittsburg Township.*

[Average of 10 acres.]

Diameter breasthigh.	Number of trees per acre.					
	Spruce.	Balsam.	Yellow birch.	Paper birch.	Mountain ash.	Mountain maple.
Inches.						
2	2.80	31.30	1.00	0.90	1.40	1.70
3	3.90	28.50	2.10	2.10	.30	.....
4	6.20	34.50	2.40	1.70	.60	.....
5	7.30	25.50	2.10	6.00	.20	.....
6	7.00	18.80	2.00	3.30	.10	.....
7	7.70	13.10	1.20	1.70	.....	.....
8	9.20	12.40	2.20	3.50	.....	.....
9	9.70	8.10	1.60	3.30	.....	.....
10	11.20	6.40	1.50	2.70	.....	.....
11	7.40	3.00	1.50	1.20	.....	.....
12	12.40	2.70	.80	1.10	.....	.....
13	8.90	1.70	.90	1.20	.....	.....
14	8.30	.60	.90	.40	.....	.....
15	7.50	.40	.90	.30	.....	.....
16	6.80	.30	1.00	.10	.....	.....
17	5.50	.....	1.00	.40	.....	.....
18	5.00	.....	.60	.20	.....	.....
19	3.10	.....	.30	.10	.....	.....
20	4.20	.....	.40	.....	.....	.....
21	2.50	.....	.60	.....	.....	.....
22	1.90	.....	.10	.....	.....	.....
23	.70	.....	.10	.....	.....	.....
24	.30	.....	.....	.....	.....	.....
25	.20	.....	.10	.....	.....	.....
26	.10	.....	.20	.....	.....	.....
27	.20	.....	.....	.....	.....	.....
30	.10	.....	.....	.....	.....	.....
Total	140.10	187.30	25.50	30.20	2.60	1.70
Trees 10 inches and over.	86.30	15.10	10.90	7.70	.....	.....

TABLE XI.—*Upper spruce slope—Waterville Township.*

[Average of 5 acres.]

Diameter breasthigh.	Number of trees per acre.				
	Spruce.	Balsam.	Paper birch.	Yellow birch.	Mountain ash.
Inches.					
2	83.60	236.20	0.60	3.00	0.20
3	29.00	160.40	2.00	5.20	.20
4	36.20	111.20	4.20	1.20	.40
5	37.00	79.00	5.20	1.00	.20
6	60.20	55.00	5.00	.40	.....
7	11.20	20.40	1.20	.20	.....
8	22.20	14.80	3.00	.....	.....
9	18.60	11.00	1.60	.....	.....
10	18.20	4.80	1.60	.....	.....
11	3.40	1.00	.40	.....	.....
12	6.00	1.00	.60	.20	.....
13	1.60	.....	.40	.....	.....
14	.60	.20	.40	.40	.....
15	.60	.....	.....	.....	.....
16	1.00	.....	.....	.....	.....
Total	329.40	695.00	26.20	11.60	1.00
Trees 10 inches and over.	31.40	7.00	3.40	.60	.....

TABLE XII.—*Upper spruce slope—Low and Burbank grant.*

[Average of 1½ acres.]

Diameter breasthigh.	Number of trees per acre.				
	Spruce.	Balsam.	Paper birch.	Yellow birch.	Mountain ash.
Inches.					
2	66.00	174.67	37.33	2.00	2.00
3	49.33	202.67	77.33	.67	2.00
4	13.33	140.00	70.67	.67	.67
5	8.00	84.67	38.00	.....	1.33
6	2.67	46.67	30.67	.....	2.00
7	1.33	24.67	13.33	.....	.67
8	.....	10.00	5.33	.....	.67
9	.....	4.00	5.33	.....	.....
10	.67	4.67	4.67	.....	.....
11	.67	2.00	4.00	.....	.....
12	.....	.67	2.00	.....	.....
13	.....	.67	4.00	.....	.....
14	.....	.67	.67	.....	.....
15	.....	.....	2.67	.....	.....
16	.....	.....	.....	.....	.....
17	.....	.....	.67	.....	.....
Total	142.00	700.03	296.67	3.34	9.34
Trees 10 inches and over.	1.34	8.68	18.68	.....	.....

Aside from these main types there are several others covering comparatively small areas. Tracts of low, level, sandy land along the Saco River bear in places a nearly pure growth of pitch pine, and large areas in the same section that were originally white pine land have now come up to good stands of second-growth white pine.

There is practically no real swamp land in northern New Hampshire, although in places the spruce flats approach such a type. There are, however, small areas of swamp or spruce bogs, chiefly in the northern part of Coos County. These have a very dense scrubby growth of black and red spruce and balsam. Such areas are, however, too small in extent to constitute a general type.

The original types are often greatly confused and changed by lumbering. Over large areas that once had a heavy stand of spruce or pine there is now a poor growth of hardwoods. But in general the type will be evident in the reproduction, and the forest will eventually revert to the original condition. On the hardwood land, however, the spruce, once removed, will never return in large quantities.

DESCRIPTION BY TOPOGRAPHIC SUBDIVISIONS.

As has already been said, the entire area under discussion was subdivided into drainage basins, the aggregate of which constitutes the northern New Hampshire region as examined. A detailed description of each of these basins will presently be given, but preliminary to this the forests of the Presidential and Carter Mountain ranges will be separately described. It will be understood, however, that these forests are parts of those to be presently considered under their several drainage basins, and are here selected for particular description not as constituting areas distinct from the various watersheds there described, but because their character is such as to make it convenient to take them up by themselves.

FORESTS OF THE PRESIDENTIAL RANGE.

Physiography.—The Presidential range is, topographically, the most important range in the White Mountains. In it are included nine peaks with elevations of over 5,000 feet. The range has a general northeast and southwest direction. It is popularly considered as extending only from Mount Madison on the north to Mount Webster on the south, and includes the following peaks: Madison, the three Adamses, Jefferson, Clay, Washington, Monroe, Franklin, Pleasant Dome, Clinton, and Webster. This stretch of country is about 15 miles long by 5 miles in breadth, and contains about 50,000 acres. Pine Mountain in the north and Rocky Branch and Montalban ridges in the south, extending to the villages of Bartlett and Jericho, are properly also parts of the range. If these are included, the area is approximately 150,000 acres.

Drainage.—This range is the source of five rivers, by which it is drained: The Saco, Ammonoosuc, Israel, Moose, and Peabody. The country south of a line drawn from Crawford's to the summit of Mount Washington is drained by the Saco River, with three good-sized tributaries—Dry River, Rocky Branch, and Glen Ellis River. North of this line the drainage is by the Ammonoosuc and Israel, flowing northwest into the Connecticut River, and the Moose and Peabody, flowing northeast into the Androscoggin River.

Soil.—The underlying rock is granitic gneiss. By disintegration and mixture with organic matter it forms a loamy sand. The depth of the soil varies with the elevation, aspect, and gradient. In the valleys and on the lower slopes the soil is generally deep, and there is very little outcropping rock. With ascent in altitude and increase in gradient the depth of soil gradually decreases, till on the steep upper slopes there is to be seen only immense masses of bare outcropping rock and scattered bowlders. On southern and western aspects the exposure to sun and wind is more severe than on northern and eastern slopes. This causes a more rapid dissipation of the organic soil, which results in the belt of deep soil being lower on the former than on the latter aspects. These facts have an important bearing on the distribution of the forest.

The forest.—Complexity and variation in forest conditions are the natural outcome of variety in slope and aspect and great latitude in elevation. As in topography, so also in forest conditions the Presidential Range offers the greatest differences. This complexity has been augmented by fire and lumbering, which often greatly change the original character of the forest. In general, however, the nature of the forest varies with the altitude. Four forest belts may thus be distinguished:

(1) Under 1,800 feet elevation, where lower slopes and valleys occur, typical hardwood land is found. Sugar maple, yellow birch, beech, and spruce are the prevailing species.

(2) From 1,800 to 3,500 feet elevation the forest is characterized by the prevalence of spruce in mixture with balsam and yellow and paper birch. This is the regular spruce slope type.

(3) From 3,500 to 4,200 feet elevation the growth is spruce and balsam, with some paper birch. It is mostly unmerchantable, being under 40 feet in height.

(4) At 4,200 feet scrub growth begins and extends up to the limit of tree growth, which varies from 4,500 to 5,200 feet in altitude, according to exposure and gradient. Above this the bare rocks extend to the summits.

The elevations given for these belts are purely averages and not in the least fixed. The character of the growth also changes somewhat with the aspect and gradient, as well as with the elevation. Thus, on

a steep, rocky southwest slope, the scrub line would be lower than on a northeastern exposure of moderate incline.

The lower slopes of the Presidential Range have been almost entirely cut over, but there is still much virgin timber left above the valleys, notably in the Low and Burbank grant, where lumbering operations have only just commenced. The effect of lumbering on the lower slopes is to increase the proportion of hardwoods in the second growth.

FORESTS OF THE CARTER RANGE.

Physiography.—The Carter Range runs parallel to the Presidential Range, and is separated from it by the Glen Ellis and Peabody rivers. This range forms a striking counterpart of the Presidential Range. The highest peak is Carter Dome, with an elevation of 4,860 feet, and there are eight peaks in all with elevations of over 4,000 feet. It includes the Carter, Moriah, and Wildcat mountains, and extends from the Androscoggin River, in Shelburne, to the village of Jackson, in the south. It is 20 miles long and 2 to 7 miles wide.

The range is entirely surrounded by the five rivers by which it is drained, the Peabody and Glen Ellis rivers on the west, the Wild and the east branch of the Saco on the east and south, and the Androscoggin on the north. The Peabody and Wild rivers flow northeast into the Androscoggin, and the Glen Ellis flows into the Saco.

Soil.—The general character of the soil and underlying rock is the same as on the Presidential Range. It is, however, important to note that the elevation of the belt of great rock exposure is lower on the Carter than on the Presidential Range. The soil plays out at a lower altitude on the former than on the latter because of the difference in elevation between the two. Consequently the belt of scrub forest growth extends to lower elevations on the Carter Range.

The forest.—The same belts of forest prevail here as on the Presidential Range. In general, the forest below 1,500 feet elevation is the hardwood type, with yellow birch, sugar maple, beech, and spruce as the characteristic species. In the sandy flats along the rivers, especially on the Androscoggin, there is considerable second-growth pine land, with spruce and balsam in mixture. Above the hardwood land the spruce slope extends up to about 3,200 feet elevation. Above this the trees rapidly decrease in size, and run out into a scrubby growth of spruce and balsam which extends up to about 4,400 feet elevation.

The forests of the Carter Range have been heavily lumbered. At first the lumbering was only for sawlogs on the lower, more accessible slopes. Later the higher slopes were taken and cut for both saw and pulp logs, and forests which had been culled before for sawlogs only were cut again for pulp. At present, the higher the slope the cleaner the cutting, both because the growth is more purely coniferous, and

FIG. 1.—SCRUBBY BALSAM AT AN ELEVATION OF 4,800 FEET ON MOUNT MADISON, NEW HAMPSHIRE.

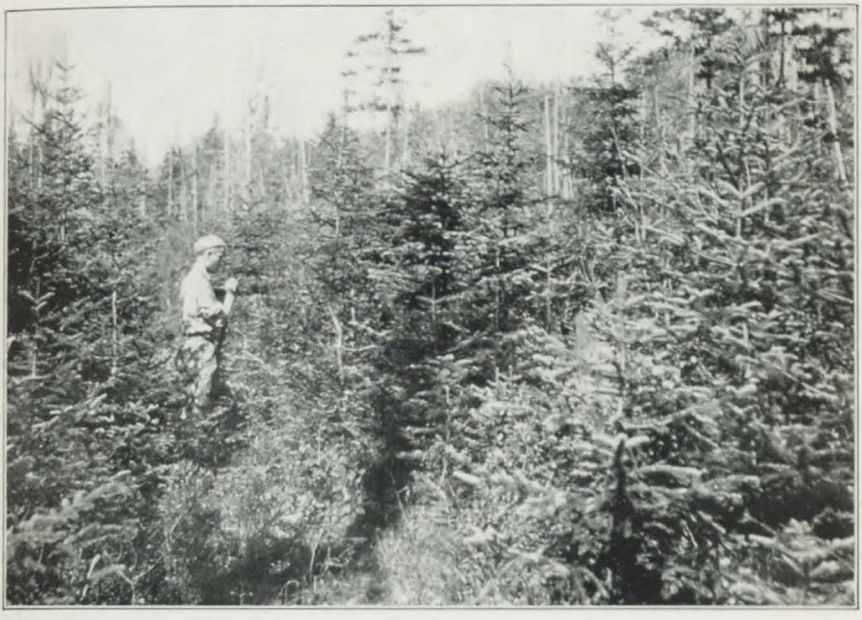

FIG. 2.—DENSE STAND OF BALSAM ON A SPRUCE BOG, LOGGED FIFTEEN YEARS AGO.

also because the exposure becomes so severe that the trees which are left will be wind-thrown. The cutting on the range now extends up as far as there is merchantable growth, to 3,500 feet elevation on the average.

The slopes draining into the Glen Ellis River, from the village of Jackson to Wildcat Mountain, have been stripped of all coniferous growth. The present stand is now an inferior growth of hardwoods. The whole south spur of Wildcat Mountain is covered, however, with a virgin spruce forest. The slopes here are very steep, and the difficulty in lumbering has so far kept the lumberman away.

The southeastern slopes of the range, drained by the Wild River, have been pretty well cut over. A logging road was run the entire length of the valley, and the lower slopes were cut over first for saw-logs only, and now contain an irregular forest of hardwoods, with considerable spruce suitable for pulpwood. The more recent lumbering, as that in the Moriah Brook Valley, has been severe, taking both saw and pulp logs. A scattering hardwood growth is all that remains, aside from a few small patches of virgin spruce on the upper and more inaccessible slopes.

The upper part of the Wild River Valley was severely burned in the spring of 1903, and but little growth now remains.

The north and west slopes of the range contain considerable areas of uncut timber on the upper portions. The lower slopes have been entirely culled of softwoods and are now being lumbered to some extent for the hardwoods.

FORESTS OF THE SACO DRAINAGE BASIN.

The Saco River watershed covers the southeastern portion of the White Mountain region. The river has its source in a small pond at the head of the Crawford Notch, on the west slope of the Presidential Range, and flows in a general southeasterly direction for about 30 miles, when it crosses the Maine State line. The area of the watershed covered by the examination is 444,435 acres.

The character of the country varies greatly in this river basin, and two distinct types are apparent. The upper portion of the river and its tributaries lie in a mountainous country cut up into deep valleys, with many high mountains crowded close together. Parts of the Presidential and Carter ranges are in this watershed, and also the high mountains in Waterville and Albany. In the southern and southeastern parts, however, the country becomes comparatively flat, and the plain level is about 480 feet. The country is here characterized by low, rounded chains of hills and a few isolated mountains, none, however, reaching great height. The soil is very sandy, and there are numerous small lakes and ponds.

Agricultural land.—The farm land lies chiefly in the eastern and

southern portions. The soil is sandy and poor, and except right along the streams the farming is not good. The principal crops are clover and timothy hay, oats, rye, wheat, corn, potatoes, peas, and beans. There are a few orchards, usually overgrown and neglected. The farming industry of this entire section has steadily declined, and is now reduced simply to meeting the needs of the inhabitants. The area under cultivation is much smaller now than fifty years ago. Many farms have been abandoned, and many have passed into other hands and been allowed to run to waste. A large area, once cleared and tilled, has thus reverted to forest, and much more is in process of reversion. This area, containing as yet no merchantable timber, is classed as waste land on the map, although a large part of it is better adapted to forest growth than to anything else.

The hardwoods of this region show great energy in seeding up old pastures and abandoned fields, and the reversion to forest conditions is very rapid. The most energetic and persistent tree in this respect is gray birch, many old fields coming up to a pure stand of this species. On low, sandy situations in the neighborhood of seed trees pine seedlings come in thickly, either as a pure stand or in mixture with the hardwoods.

The forest.—The forest varies with the locality. In the northern part of the watershed, on the steep mountain slopes, spruce forests predominate. On the lower sandy plains pine is the chief species.

The northwestern part, or upper portion of the Saco basin, is in the high mountains of the Presidential and Carter ranges. The greater part of this section has been heavily lumbered and much of it severely burnt in the past, and in consequence the present growth consists almost entirely of hardwoods.

The eastern part of the Sandwich Range lies in this watershed, the divide running over Sandwich Dome and Tripyramid. There is a great deal of virgin forest on the mountain slopes in this section, and in Albany and Waterville the stand of spruce is the heaviest in New Hampshire. The best stands are on the slopes of Tripyramid and Passaconway, at an elevation of 2,500 to 2,800 feet, and on the east slope of Sandwich Dome, between 2,200 and 3,000 feet elevation. The latter stand consists of 90 per cent spruce, with about 8 per cent yellow birch and a very little balsam in mixture. The mature spruce range from 8 to 24 inches in diameter and from 80 to 90 feet in height. The slope is steep, with numerous rock outcroppings and a thin, loamy soil, but without moss. There is consequently a fair exposure of mineral soil, and the reproduction of spruce and balsam is good.

This stand merges into an upper spruce slope type on the upper side, and at an elevation of 3,500 feet consists of about 75 per cent spruce, with 15 per cent balsam and much yellow birch. The forest

here contains many dead trees and bare poles, but has a fair density. The mature spruce are rather scrubby, and seldom over 50 feet in height. There is a thick layer of moss, and the reproduction is dense, consisting almost entirely of balsam.

Above this type the forest assumes a decidedly scrubby character, with a very dense growth of balsam, up to an elevation of 3,800 to 4,000 feet. Beyond this the peaks of the Sandwich Range rise as bare granite ledges, with no vegetation save where a few stunted balsam and spruce, hardly more than bushes, find a footing in the crevices of the rocks.

Hardwood lands.—The hardwood areas of the valley section represent either old waste lands or cut-over lands where the stand has attained merchantable size, or land whose original growth was hardwoods. The latter is usually on gentle slopes or low, rolling hills where the soil is of good depth.

The composition of the hardwood forests varies greatly. Often it is an almost pure stand of sugar maple, beech, or birch, or of these species in mixture with spruce, pine, or hemlock. Much of the hardwood land has been freely logged for cordwood and birch bolts, and the greater part of the large timber has been removed. Large areas of second-growth hardwoods are found around Jackson and through the entire watershed.

Pine lands.—Throughout the lower part of the Saco basin there are considerable stretches of low, level, sandy country where the original growth was pure stands of pine. The old growth was cut from 40 to 120 years ago. The conditions, however, are remarkably well adapted to pine reproduction, and the second growth consists of practically pure white pine. Much of this second growth also has been cut over. In many places the white pine is mixed with red pine in varying proportions, and occasionally, over small areas, the red pine occurs pure. The only virgin growth of white pine now remaining is at Intervale. This is a last remnant of a pure stand which once covered this entire section.

Pitch pine land.—The country around Silver Lake, in the township of Madison, and extending north to Albany and Conway Center, originally contained a heavy growth of pitch pine. This area consists of fairly level, rolling stretches, becoming more hilly toward the north, and with a deep soil of very coarse sand. It was heavily cut over 30 to 40 years ago, and much of it has been severely burned since. The growth now consists of pitch pine poles and saplings, 3 to 8 inches in diameter and 25 to 30 feet in height, either widely scattered or in small, isolated groups. The ground is covered with a very dense growth of barren oak (*Quercus pumila*) 4 to 5 feet in height, which chokes out nearly all other growth. Beneath the oak there is, over most of the area, a dense matting of sweet fern. Through much of

this area there are evidences of repeated fires. Where these have occurred there is no reproduction, and nearly all the barren oaks have 2 or 3 feet of dead tops. The lower half of the pines are burned and scarred, and though they are still living their growth and vitality are seriously impaired. Where fires have been kept out the conditions are somewhat better. There is a good reproduction of pitch pine and a thrifty seedling growth of gray birch, sugar maple, popple, and red maple, but the stand is as yet of little value.

FORESTS OF THE PEMIGEWASSET DRAINAGE BASIN.

This covers the southwest portion of the White Mountain region, and includes an area of 343,512 acres. The Pemigewasset River rises in the Franconia Notch. Flowing due south, it receives the drainage of Lake Winnipiseogee and forms the Merrimac River. The chief tributaries in the region examined are the East Branch and the Mad River. The former drains the township of Lincoln, and the latter Waterville.

The entire watershed is a decidedly mountainous country; the valleys are narrow, and there is very little level land. It is bounded on all sides by high mountains, and includes in its area Mounts Lincoln and Liberty, the former over 5,000 feet in elevation. Mounts Tecumseh, in Waterville, and Osceola, on the line between Lincoln and Livermore, are within this basin, and also the low range of hills called the Squam Mountains, just north of Squam Lake. On the west, Mount Mousilauke, reaching an altitude of 4,810 feet, is the highest peak.

Agricultural land.—The agricultural land in this watershed lies chiefly around the southern and eastern borders of the region examined, along the line of the Boston and Maine Railroad. There is also considerable farming land in the Pemigewasset and Mad River valleys.

The forest.—Practically the entire watershed was originally covered with a spruce forest. Of this original growth but little now remains. The largest areas that have not yet been logged are in the townships of Lincoln and Waterville. Along the East Branch of the Pemigewasset, in the former township, between Mounts Lincoln and Liberty on the west and Mounts Bond and Carrigain on the east, is a heavy forest of spruce. The composition of this forest consists of spruce, with a strong admixture of hardwoods and balsam, the percentage of the latter increasing with the altitude. A few old pines still remain, and in the swampy places there are patches of white cedar.

In general the best spruce land is below an altitude of 2,800 feet, while white pine is of commercial importance only below 1,500 feet. The best stands of spruce are usually found on the north and northeast slopes of the mountains, above 1,000 feet elevation. Below this the white pine and hardwoods are able to occupy the ground.

Lumbering has been carried on only in the more accessible portions of the township of Waterville, especially along the lower course of Mad River. Fully 60 per cent of the township still contains a fair merchantable stand of spruce, and a great deal of virgin timber still remains on Mounts Tripyramid, Kancamagus, and Osceola.

There are large areas over the entire watershed that have been lightly cut over, or cut years ago, and now have a fair merchantable growth of spruce pulpwood. These stands are usually well mixed wtih hardwoods—maples, beech, yellow birch, and popple—and considerable balsam.

Nearly all the pure hardwood forests are second growth, and are due to a change of species after lumbering and fires. Along the valley of the Hancock Branch, in Lincoln, the forest was completely logged. The upper and steeper slopes were clean cut, the unmerchantable stuff being used as skids and shear poles, down which the merchantable timber was rolled to the nearest logging road. These slopes have grown up to a thicket of hardwoods and balsam, with very little spruce. Popple, wild red cherry, and yellow birch are the chief species. This grades off into more mature stands on the older cuttings, which often contain also considerable young spruce and balsam. Hemlock is common on the lower slopes.

The largest area of hardwood land is around Mount Carr, in the townships of Warren, Ellsworth, Rumney, and Wentworth. The spruce was taken out, leaving the mature hardwoods, and now good second-growth hardwoods have come in. In addition to the usual sugar and red maples, beech, and yellow birch, there is also a large amount of red oak in this section, and considerable white ash.

Many fires have occurred in this watershed, in the Zealand Valley and also in the vicinity of North Woodstock; and throughout on the old cuttings there are traces of fires in the past. On these areas the softwoods are usually lacking, and there is a prevalence of popple and birch, with dense thickets of wild red cherry on the more recent burns.

FORESTS OF THE AMMONOOSUC DRAINAGE BASIN.

The Ammonoosuc River rises in the Lake of the Clouds, on the upper slopes of the Presidential Range, and flows into the Connecticut at Woodsville. The portion of this river basin examined includes the western slope of the Presidential Range from Mount Clinton to Mount Adams, the southern slopes of the Dartmouth Range and Cherry Mountain, and the north and west slopes of the divide between the Connecticut and the Pemigewasset watersheds. Its area is 142,539 acres. The western portion of the drainage basin, consisting chiefly of farming land along the Connecticut River, was excluded.

The upper portions of this basin are very high. From Mount Mousilauke on the south to Mount Adams on the northeast there is

a continuous series of peaks and mountains from 3,000 to 6,000 feet in altitude. The upper slopes are steep and barren, often totally devoid of growth, while merchantable timber ceases at about 3,500 feet elevation.

Agricultural land.—Around Franconia and Bethlehem farm land predominates, and the forest becomes of only secondary importance. There are also large areas of agricultural land in Easton.

The forest.—There is practically no virgin forest left in this watershed save a very few isolated patches on the upper slopes. The country has been entirely cut over and subject to severe fires. Where these have occurred, as on Cherry Mountain and in the Zealand Valley, the growth consists chiefly of wild red cherry, popple, and yellow and paper birch. Balsam and spruce show a tendency to come in as the other species die out, but where sugar maple and beech gain a footing a hardwood forest is the result.

On the lowland spruce and balsam form a large part of the second growth, but on the lower slopes hardwoods predominate.

Extensive areas of culled forest exist in Franconia, and on the slopes of Mount Garfield and the Twin Mountains considerable spruce is left. The western slope of Mount Moosilauke also has a considerable growth of spruce. In general, however, the greater part of this watershed is coming up to second-growth hardwoods.

FORESTS OF THE ISRAEL AND UPPER AMMONOOSUC DRAINAGE BASINS.

The Israel and Upper Ammonoosuc rivers are both tributaries of the Connecticut, the former flowing into it at Lancaster and the latter near Groveton. The area of the two watersheds examined is 220,499 acres. The Israel drains the northwest slopes of Mounts Adams and Jefferson in the Presidential Range, the north slopes of Cherry Mountain and the Dartmouth Range, and the south slopes of the Jefferson Mountains. The Upper Ammonoosuc rises in Randolph, on the northwest slope of the Crescent Mountains, and flows northwest.

These two basins therefore include the entire Pliny and Pilot ranges, and extend as far north as the Dixville Mountains, and east to the divide of the Androscoggin watershed. The greater parts of the townships of Lancaster and Northumberland were excluded from the examination, since they consist chiefly of farm land.

The country is mountainous, but for the most part the slopes are moderate. The highest peaks are Mounts Adams and Jefferson, rising nearly 1,000 feet above timber line. The tallest, Mount Jefferson, reaches an altitude of 5,725 feet.

Agricultural land.—There is a considerable area of cleared and improved land along the Israel River and on the lower slopes of the Jefferson Mountains. Farther north there is a strip of cleared land along the line of the Grand Trunk Railroad.

The forest.—These two watersheds have been heavily cut over at periods during the past fifty years. The only virgin forest now remaining as an area in Ervings location and a strip on the slopes of Mounts Adams, Jefferson, and Bowman, in the Low and Burbank grant. Ervings location is a small, well-wooded tract in the southeastern part of the Dixville Mountains. Owing to its being near no stream suitable for driving it has escaped lumbering. It is not, however, a very good spruce country, and hardwoods predominate except on the upper slopes. On the northwest slopes of Mounts Adams and Jefferson, in the Presidential Range, between the altitudes of 2,500 and 3,500 feet, is a virgin spruce slope. With these two exceptions the entire region has been cut over and the predominating growth is now hardwoods.

Severe fires have occurred on the slopes of Cherry Mountain and the Dartmouth Range, and on these old burns the growth is very poor. A large fire occurred in the spring of 1903 in the townships of Kilkenny and Berlin, which burned over about 18,000 acres.

The Pliny Mountains in Jefferson consist of three peaks, the tallest of which is 4,029 feet in height. The lower slopes are covered with hardwood coppice, the result of lumbering and fire, while the upper slopes have considerable spruce and balsam. There is a large area of waste land on the summits.

Over a great deal of the lumbered land in these basins there is very little growth but hardwoods, as on the Randolph Hills, while in the country between Crescent and Round mountains and through the northern parts of the basins there is considerable spruce and balsam left. Here the chief species are balsam, spruce, yellow and paper birch, hemlock, and sugar maple. This represents an original forest of mixed hardwoods and spruce, in which the spruce probably formed 50 per cent of the entire growth. The reproduction of spruce and balsam is generally good, forming 30 to 50 per cent of the entire reproduction.

The characteristic growth which springs up after logging on trails and clearings is mountain and red maple, with some black and wild red cherry, striped maple, and gray and yellow birch. Spruce and balsam usually gain a slight foothold later and come in as a subsequent growth on such spots, the balsam predominating.

On the gentle slopes there were originally large quantities of white pine, which is still abundant in the second growth.

FORESTS OF THE ANDROSCOGGIN DRAINAGE BASIN.

The Androscoggin River is the natural outlet of the Rangeley Lake system. This is a chain of six lakes in Maine, the lowest of which, Umbagog Lake, lies two-thirds in New Hampshire. The Androscoggin, flowing out of this lake, receives the Magalloway River drainage, and then flows in a southerly direction until, striking the White

Mountains, it turns east into Maine. Thus, though the river starts in New Hampshire, it receives its chief water supply from Maine.

The area of this watershed in New Hampshire is 344,312 acres, of which 6,280 acres are lakes and ponds. It includes the northern slopes of the Presidential and Carter-Moriah ranges in the White Mountains, and extends north in a strip approximately 10 miles wide to the Dixville Mountains. Its chief tributaries in the White Mountain section are the Peabody and Moose rivers, which rise on the slopes of the Presidential Range.

Agricultural land.—There is a considerable area of farm land in this watershed, lying chiefly in the valley of the Androscoggin River. The greater part is in Gorham and Shelburne. There are also many abandoned fields, which are coming up now to a second growth of softwoods.

The forest.—The largest areas of virgin forest in this basin lie on the north slope of the Presidential Range, in the Low and Burbank grant and the Thompson and Meserve purchase. Aside from this the entire watershed has been cut over more or less heavily.

Extensive fires have occurred. The Wild River Valley, on the east slope of the Carter Range, was badly burned over in the spring of 1903, and Pine Mountain, in the township of Gorham, has been repeatedly burned.

Originally a heavy stand of white pine covered the whole of the Androscoggin Valley, but of this nothing now remains but a few scattered trees. Considerable areas of second-growth pine occur, however, at the lower elevations, and it often comes in with great energy on old fields and abandoned pastures.

The country throughout the townships of Berlin and Success has been most heavily lumbered and badly burnt. It contains at present very little growth of any value. There was formerly considerable larch on the low, swampy land, but an invasion of the larch sawfly in 1885 killed off all the old growth not already cut. On some of these areas, however, there is now a thick larch reproduction mixed with balsam.

The softwood reproduction in the northern section is generally good, spruce and balsam maintaining themselves fairly well on the cut-over land, and usually forming 10 to 20 per cent of the young growth.

The townships of Errol and Cambridge were logged thirty-five or forty years ago for white pine, and twenty-five or thirty years ago for spruce sawlogs, only the best spruce being taken. Comparatively little cutting has been done there since. There is now a good growth of softwoods, balsam predominating. The popple is very abundant throughout, with considerable yellow and paper birch, beech, and sugar and red maples in mixture.

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FIG. 1.—VIRGIN SPRUCE WITH DENSE BALSAM REPRODUCTION ON MOUNT JACKSON, NEW HAMPSHIRE.

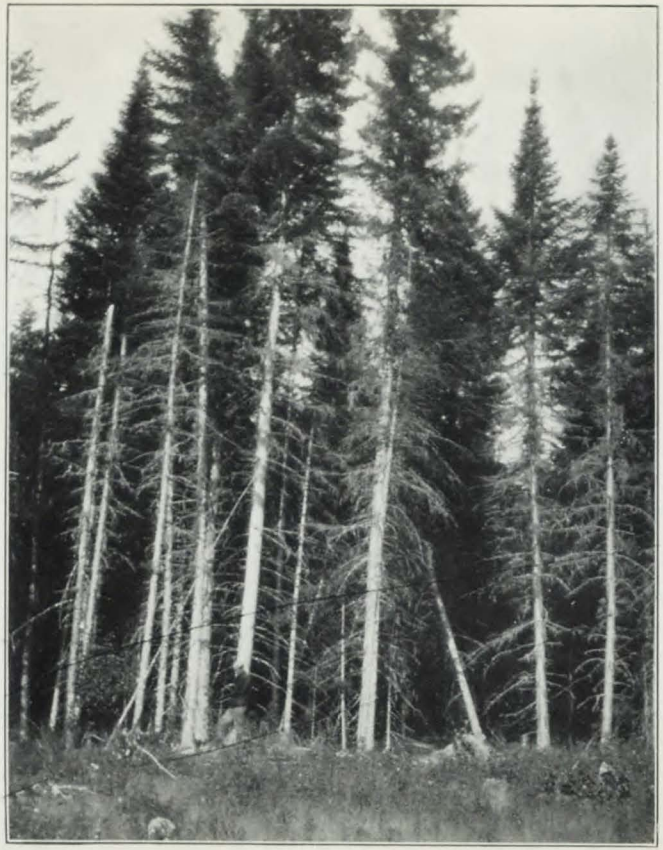

FIG. 2.—SECOND-GROWTH SPRUCE AND BALSAM NEAR PITTSBURG, NEW HAMPSHIRE.

There are small areas of swampy land near the Androscoggin River. The principal growth in these places is an open stand of scrubby black spruce, running up to 9 inches in diameter and 40 to 50 feet in height. There is also some white cedar and balsam on these spruce bogs.

Above Errol and along the Magalloway River and Clear Stream the country is cut up into small tracts, owned principally by farmers and small lumbermen, and has been very generally logged over within the last twelve years.

FORESTS OF THE MAGALLOWAY DRAINAGE BASIN.

The country drained by the Magalloway River lies in the northeastern corner of the State. The river itself lies just across the State line in Maine, and, flowing slightly southwest, crosses into New Hampshire just above Umbagog Lake, where, receiving the drainage of the entire Rangeley Lake system, it forms the Androscoggin River.

The area drained by the Magalloway River in New Hampshire covers 135,960 acres. It includes the east slopes of Mounts Magalloway and Pisgah and the eastern and southern slopes of the Crystal Mountains. Its chief tributaries are the Dead Diamond and the Swift Diamond rivers.

The country is rough, with many low ridges and low mountains, and is well watered with innumerable brooks and small streams. The general base level varies from 1,200 to 1,800 feet, and there are no mountains over 3,700 feet in height. As a result, no peaks are above timber line, and, with the exception of Mounts Magalloway and Carmel, the mountains are all covered with merchantable growth.

Agricultural land.—There is practically no cleared land in this drainage basin, and there are no towns or settlements save the lumber camps.

The forest.—This entire region is a spruce country and is, at present, the best timbered watershed in New Hampshire. The southern half has been practically all cut over at one time or another, but as a rule the cutting has been light, and there is much merchantable stuff left, while the entire northern part of the basin is still virgin forest.

The country lying along the Swift Diamond River and its tributaries, and extending up to an elevation of 2,500 feet on the bordering mountains, contained originally two distinct types of forest. The first, found along the main stream and the lower courses of its tributaries, and rarely running to an elevation of over 1,800 feet on the mountain slopes, was made up of a heavy growth of spruce and balsam, with a little white spruce in mixture. Above this type came the second, a hardwood slope, extending up to the divides. The chief growth was sugar maple and yellow birch, with considerable spruce and balsam in mixture. This country has been heavily logged within

the past twenty years. All of the valley softwoods have been cut, and the slopes below 2,000 feet have also been logged. The virgin forest remaining lies on the southern slopes of the Crystal Mountains. It consists of a scattered growth of tall, well-formed spruce, in mixture with a predominating growth of hardwoods.

On the cut-over land considerable small spruce has been left, mostly under 8 inches in diameter. The softwood reproduction, particularly balsam, is good in the valleys, but poor on the slopes, where, with the exception of a thick balsam reproduction on a few steep, mossy ledges, the young growth is principally hardwoods.

The country along the Little Dead Diamond stream, in the Atkinson and Gilmanton Academy grant, has also been logged over. The cutting has been very conservative. Considerable spruce remains, and there is excellent softwood reproduction on the lower slopes. North of this the drainage basin has not been lumbered, and the forest consists of virgin spruce land.

Along the valleys the forest consists of spruce flats. This type follows the streams closely, rarely running up the moderate slopes of their basins to an elevation of more than 100 or 200 feet above the bed of the stream, and occupying in general the lower and more poorly drained areas of the region. The forest of this type is a dense, almost pure stand of mature softwoods. Black and white spruce, with some red spruce and a little balsam and white cedar, are the principal species. The trees are mostly small in diameter, and slender and tall in form. The ground is covered with a heavy matting of moss, bearing a moderately heavy reproduction of balsam and black spruce, with a scattering of the other species. On the drier valley bottoms red spruce forms the dominant growth. The trees here are larger and better formed, running from 8 to 24 inches in diameter, while the stands on the swampy ground will not average more than 12 to 13 inches in diameter. The spruce flats represent the densest softwood forest of the region, but not the best individual development of the trees.

Just above this spruce flat type, and extending up the moderate slopes often to an elevation of 2,200 or 2,300 feet, are the spruce slopes. These slopes have a fairly deep soil and good drainage. The individual development of the trees is better than on the flats, the spruce running from 8 to 28 inches in diameter and occasionally reaching a height of 95 feet. In marked distinction from the flats, the chief conifer here is the red spruce, there being little balsam and almost no white spruce, while the hardwoods form from 25 to 40 per cent of the stand. Yellow birch and sugar maple, with some paper birch and beech, are the chief hardwood species. In consequence of the decreased density of the forest as a whole the ground cover is correspondingly heavier, and is more shrubby and herbaceous than in the preceding type.

Above these lower spruce slopes come the hardwood slopes. A heavy growth of fine mature hardwoods forms in this region the typical forest of the moderate middle slopes, running up to the summits of the low, rolling hills. Rarely, on the higher mountains, it rises above an altitude of 2,400 feet. These slopes have a moderate gradient, good drainage, and a fairly rich, loamy soil of good depth. When these conditions are present, the chief growth is usually hardwoods, though spruce slopes occasionally occupy areas of the same character, owing, probably, to especially favorable conditions for the distribution of seed.

The hardwoods on these slopes are yellow birch, sugar maple, paper birch, and beech, forming, together, 60 to 75 per cent of the entire stand. Spruce and balsam form the remainder of the growth. This mixture with hardwoods seems to favor the development of straight, full-boled trees of good height, making excellent timber. The reproduction is almost entirely hardwoods.

Throughout this type the spruce and balsam occur widely scattered or in small groups of a few trees. Frequently, however, on the steeper and higher slopes rather small areas of dense softwood growth are found, with few or no hardwoods in mixture. These areas occur chiefly on the steep, thin-soiled, rocky ledges or precipitous slopes which are found frequently in this region—often the result of glacial erosion. Almost pure spruce and balsam occupy these places, where the gradient is too steep and the soil too thin and poor for hardwoods. The trees are short and scrubby, seldom over 50 feet in height. Often in the more exposed situations the chief species will be balsam, with but little spruce and some yellow birch. Such growth occurs on the summits of Crystal and Magalloway mountains. These forests have suffered a great deal from windfall and death of the balsam. In general, however, there is very little scrub growth in this watershed.

FORESTS OF THE UPPER CONNECTICUT DRAINAGE BASIN.

The drainage basin here called the Upper Connecticut consists of the entire Connecticut drainage area in New Hampshire as far south as Groveton Junction, where the drainage basin of the Upper Ammonoosuc River joins it. The area of this basin examined was 320,720 acres, of which 5,120 acres are water, consisting chiefly of the Connecticut lakes. The township of Colebrook and a large part of Stewartstown and Columbia, consisting, as they do, for the greater part, of agricultural land, were not examined.

The country in general consists of low, rolling hills. The chief mountains are Mounts Pisgah and Magalloway on the east and the Dixville Mountains and other low ranges on the south. The country immediately around the lakes is flat, and there are a few bogs and swamps, although none of large extent.

Agricultural land.—South of the First Lake there is a great deal of cleared and improved land along the valley. The farming land in the townships of Colebrook and Stewartstown is considered as good as any in the State.

The forest.—With the exception of a small area in the extreme north and a narrow strip in the northeast, the whole of this river basin has been logged. The virgin forest consists of a strip about 6 miles wide on the north of Pittsburg township and a narrow strip on the western slopes of Mounts Carmel, Magalloway, and Pisgah. The forest here is essentially the same as the virgin forest in the Magalloway basin adjoining. There is no scrubby growth save on the summit of Mount Magalloway. The principal types are spruce slope and hardwood land, this being a region of slopes and ridges, with few flat valley bottoms. The spruce flat type is confined to a narrow strip along the East Inlet, the Connecticut River, and the East Fork. Its most typical form along these streams is a swampy or bog-land growth, consisting of dense stands of black spruce, with considerable red spruce and balsam in mixture (Pl. III, fig. 2). The rest of this drainage basin consists of cut-over or culled land and second growth.

The country was cut over first for pine and then for spruce, although but little pulpwood was taken in the northern part. The growth now, through Pittsburg, consists chiefly of mature hardwoods, yellow birch, sugar maple, and beech, with considerable small spruce and balsam (Pl. IV, fig. 2). Through the southern part of the watershed the stand is almost pure hardwoods, with only a little spruce and hemlock remaining.

The second growth throughout the valley is excellent, and is almost entirely softwood. Spruce, pine, and balsam come in very rapidly on abandoned fields and pastures. On the moister soils the typical growth is larch, cedar, and balsam, with some spruce and red maple scattered through. The second growth shows an excellent promise for the future of this region.

A considerable area around the First Lake has been injured by flooding. The water was backed up here during logging operations. This area now forms a narrow band around the lake (Pl. II, fig. 2).

SECOND GROWTH AND REPRODUCTION.

The problem of second growth in New Hampshire is easily next to the fire problem in importance. In fact the chief service of fire laws will be to keep fire from the second growth after lumbering. All intelligent recommendations in regard to the silvicultural treatment of the forest must be based on a thorough knowledge of second growth and reproduction. Special studies of the characteristics of the different forest trees must be supplemented and coordinated by a general

study of the competition which takes place between them for a place in the forest, the conditions which determine its make-up under different circumstances, and the effect of man's interference. When it is known what will happen, for example, after lumbering in a particular locality, the operation can be planned with reference to the effect on the future stand of timber. Recommendations of high economic importance in the cutting of the forest can be made only when the conditions governing second growth are known.

The value of second growth is well illustrated by the stumpage price of the so-called sapling pine, which averages $3.25 per thousand at an age of 40 to 50 years. This often cuts 20,000 board feet to the acre, and sometimes as high as 40,000 feet, of boxwood lumber. The stumpage price of second-growth spruce and balsam for pulp is $2 to $2.50 per cord. The value of popple and paper birch, which are rapid-growing trees, coming up on cleared land, is nearly as high as that of spruce and balsam, and they become merchantable in twenty-five or thirty years.

OCCURRENCE.

The general nature of the second growth varies with the forest region. Pine is the most important second-growth species. In the White Mountain region and the northern part of the State, spruce, balsam, paper birch, and popple are all-important second-growth trees. The nature of the growth differs more particularly according as it is found, (1) in the forest; (2) on lumbered land; (3) in pastures and abandoned fields; (4) on burns. The subject will be considered under these heads.

GROWTH IN THE FOREST.

In a virgin forest, reproduction and succeeding growth are extremely slow. Suppressed seedlings of tolerant species continue to exist under dense shade, but their growth is scarcely perceptible. When openings are made in the forest by the decay and death of the veteran trees, these suppressed seedlings begin to grow more rapidly under the stimulus of increased light. Reproduction of the more intolerant or light-demanding species also takes place in the natural openings formed, and these make up for lack of tolerance in rapidity of growth. Vacant places in the forest are thus soon filled up with a flourishing succeeding growth of tolerant and intolerant species, struggling against each other for a place in the new stand.

The tolerant species whose seedlings continue to grow under the shade of the mature trees are spruce, balsam, hemlock, sugar maple, and beech. As these are the only species which can endure dense shade for any length of time, they constitute the prevailing reproduction in the unculled forest. Birches, cherry, popple, and mountain ash, intolerant and rapid-growing, seed profusely in the openings.

The character of the reproduction varies also with the forest type. Counts on three sixteenth-acre plots on spruce slope, the same number

on hardwood land, and 1 square rod in a windfall on spruce slope, gave the following average results:

TABLE XIII.—*Reproduction in virgin forest.*

Species.	Average number of seedlings per one-sixteenth acre.			Species.	Average number of seedlings per one-sixteenth acre.		
	Hardwood land.	Spruce slope.	Spruce slope windfall.		Hardwood land.	Spruce slope.	Spruce slope windfall.
Beech	2,902			Yellow birch	46	14	
Maples	1,671	49		Mountain ash			3
Paper birch			1,285	Hemlock		1	
Spruce	25	353	108	Total	4,644	520	1,537
Balsam		103	141				

On hardwood lands beech and sugar maple seedlings constitute almost the entire young growth. The thick ground cover of undecomposed hardwood litter on this type is unfavorable to coniferous germination, but forms a suitable seedbed for sugar maple and beech. For this reason such land when cut over always comes up to hardwoods, which are already on the ground waiting for an access of light to start active growth.

On the spruce slope type there is a good reproduction of conifers. The seedbed here—coniferous duff covered with moisture-holding moss—is better suited to their germination than hardwood land. On the upper portions of this type windfall is often quite common. After these windfalls the character of the stand is changed, for a time at least. A one-sixteenth acre plot taken on a 50-year-old windfall showed the following stand of trees:

TABLE XIV.—*Reproduction on one-sixteenth acre of 50-year-old windfall on spruce slope.*

Species.	Number of trees.	Average diameter breast-high.
		Inches.
Paper birch	12	6.8
Spruce	11	5.2
Balsam	3	4.2
Yellow birch	1	6.0

Upper spruce slopes have almost entirely softwood reproduction, particularly balsam. The softwoods are able to hold their own on this type after windfall or lumbering. Where landslides occur on the steep, forest-clad slopes, and everything is carried off down to the bare underlying rock, natural reforestation is extremely slow and depends on the gradual accumulation of soil.

On coniferous flats reproduction and second growth of those conifers which are the prevailing species are excellent. The mossy ground cover which is generally present is best suited to balsam.

GROWTH ON LOGGED LAND.

In the White Mountain region most of the logging has been done on the lower slopes. The effect is to increase the proportion of hardwoods, for a time at least, in the succeeding stand. The proportion of conifers increases with the elevation and gradient, in the growth after cutting as well as in the original forest.

The results from sample plots 1 rod square on lumbered areas are given in the following table:

TABLE XV.—*Reproduction on cut-over land.*

Species.	Average number of seedlings per one-sixteenth acre.			Species.	Average number of seedlings per one-sixteenth acre.		
	Hardwood land cut clean 2 years ago.	Spruce slope cut clean 6 years ago.	Spruce flat cut clean 7 years ago.		Hardwood land cut clean 2 years ago.	Spruce slope clean cut 6 years ago.	Spruce flat cut clean 7 years ago.
Yellow birch	38	170	35	Red maple			5
Wild red cherry	65	18	10	Ash			3
Witch hobble	30			Aspen			3
Sugar maple	25			Total	158	188	56

On coniferous flats there is abundant hardwood reproduction immediately following logging, but there is usually sufficient young coniferous growth already on the ground to make up for this, so that the stand will in the end be mainly softwoods. On the spruce slope and spruce flat plots which formed the basis of Table XV there were left after the logging 250 and 135 spruce and 20 and 53 balsam, respectively. That these softwood seedlings eventually crowd out the hardwoods is shown in the following table:

TABLE XVI.—*Stand on a flat cut clean forty years ago.*

Diameter breast-high.	Number of trees on one-sixteenth acre.				
	Spruce.	Balsam.	Paper birch.	Yellow birch.	Maples.
Inches.					
1	5	3		3	9
2		2	2	2	2
3	1	4	1	1	3
4				1	
5	1	3	1		3
6			1		1
7		1			1
8		2			
9	2	1			
10	1				
12		3			
13		1			
19		1			
Total	10	21	5	7	19

These tables indicate that the conifers are able to hold their own after logging on the spruce slopes and flats, but not on the hardwood lands.

GROWTH ON PASTURES AND ABANDONED FIELDS.

A large area in New Hampshire, originally cleared for pasture and agricultural purposes, but subsequently abandoned as unprofitable is covered with forest growth. In the white pine region along the Saco River there are numerous stands of excellent pasture pine which yield, when cut, as high as 40,000 board feet of boxboard lumber to the acre. In the White Mountain region and in the extreme northern part of the State the abandoned land is often covered with a thrifty growth of spruce and balsam.

The following sample plots serve as an indication of the stand of spruce and balsam at different ages in pastures, and will give an idea of what may be expected from old-field growth.

TABLE XVII.—*Reproduction on old fields and pastures.*

Plot No.	Area.	Age.	Species.	Number of trees.	Average height.	Average diameter breast-high.
	Acres.	*Years.*			*Feet.*	*Inches.*
1	1/8	5–15	Spruce	88	6	
			Balsam	25	8	
			Total	113		
2	1/8	15–20	Spruce	65	[a]20	1.5
			Balsam	114		2.0
			White pine	13		2.8
			Total	192		
3	1/8	20–25	Spruce	13	[a]30	4.2
			Balsam	60		3.6
			Others	3		1.4
			Total	76		
4	1/8	25–30	Spruce	35	[b]30–40	2.0
			Balsam	57		3.1
			White pine	31		2.8
			Hemlock	33		1.9
			Maple	30		2.4
			Total	186		
5	1/8	30–35	Spruce	44	[a]35	4.0
			Balsam	9		5.5
			Hardwoods	10		2.3
			Total	63		

[a] For dominant trees.

[b] For dominant pine and balsam.

TABLE XVII.—*Reproduction on old fields and pastures*—Continued.

Plot No.	Area.	Age.	Species.	Number of trees.	Average height.	Average diameter breast-high.
	Acres.	*Years.*			*Feet.*	*Inches.*
6	1/16	35-40	Spruce	68	[a]35-40	3.9
			Balsam	19		5.1
			Hardwoods	17		1.8
			Total	104		
7	1/8	40-45	Spruce	99	[a]50	8.3
			Balsam	8		6.2
			White pine	5		7.6
			Total	112		

[a] For dominant trees.

A certain amount of grazing is beneficial to the growth of the conifers, for it tends to keep down the hardwood seedlings and sprouts. The cattle eat the broadleaf foliage, and this is one reason why the second growth on pastures is mainly coniferous. There is frequently a considerable admixture of the birches, popple, and aspen, which form good nurse trees for the softwoods.

Where grazing is very slight the pasture sometimes grows up first to the hardwoods with light-winged seed, as is the case after fires. The conifers gradually creep in under these light-foliaged, intolerant species. They are only slightly suppressed by them, and in time will crowd them out altogether. The following sixteenth-acre plot illustrates how, under such conditions, softwoods come up under the hardwood growth.

TABLE XVIII.—*Reproduction on lightly grazed land.*

Species.	Number of trees.	Average height.	Average diameter breast-high.	Species.	Number of trees.	Average height.	Average diameter breast-high.
		Feet.	*Inches.*			*Feet.*	*Inches.*
Spruce	38	15	2.0	Paper birch	46	35	4.1
Balsam	12	20	2.3	Red maple	18	25	2.7
Hemlock	31	15	1.6	White pine	1	10	1.0
Popple	4	45	6.4	Total	153		
Yellow birch	3	20	2.4				

The height growth of seedling spruce and balsam on pastures and old fields is very different from that in the forest. The following table shows the average growth in height on the former situations of four of the principal old-field species.

TABLE XIX.—*Height growth on old fields.*

Species.	Age—Years.							
	5	10	15	20	25	30	35	40
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Spruce	0.8	2.4	6.0	10.0	16.0	28.0	35.0	.....
Balsam	1.2	3.7	10.6	18.3	.....	.....	.....	.....
Popple	9.0	16.0	23.0	.....	.....	.....	.....	.....
White pine	1.2	8.0	15.0	22.4	30.0	38.0	45.6	53.0

In the white pine country, as along the Saco River south of the Crawford Notch, white pine is the most important and valuable old-field growth. It comes up almost pure with a slight mixture of gray birch and popple, or of pitch or red pine.

The following sample plots show the growth of white pine stands at different ages under favorable conditions.

TABLE XX.—*White pine on old fields.*

Plot No.	Area.	Age.	Species.	Number of trees.	Average height.	Average diameter breast-high.
	Acres.	*Years.*			*Feet.*	*Inches.*
1	¼	3–10	White pine	804	5	.....
			Others	108	.....	.....
2	¼	10–15	White pine	1,640	7	.....
			Others	280	.....	.....
3	¼	15–20	White pine	1,020	20	3.0
			Others	240	.....	2.5
4	¼	25–30	White pine	525	25	4.1
			Others	55	.....	3.0
5	¼	30–35	White pine	355	40	6.2
			Others	4	.....	.....
6	¼	35–40	White pine	187	55	7.0
			Others	34	.....	2.5
7	¼	40–45	White pine	170	65	8.7
			Others	25	.....	6.0
8	¼	45–50	White pine	175	70	9.0
			Others	60	.....	8.0
9	¼	50–55	White pine	180	75	11.0
			Others	.....	.....	.....
10	¼	60–65	White pine	137	80	12.6
			Others	5	.....	.....
11	¼	65–70	White pine	300	85	12.5
			Others	5	.....	.....

GROWTH ON BURNS.

The effect of fire on growth is discussed more in detail under another heading. In general the effect is to kill all young coniferous growth which has been left in lumbering. The burn is immediately seeded up by intolerant, rapid-growing hardwoods with light-winged seeds, capable of being carried long distances by the wind, such as

the birches, popple, and aspen. Frequently it comes up to a thick growth of wild red cherry from seeds already in the ground, collected there for many years from deposits of birds.

When the burns are seeded up to a good growth of paper birch and popple the expectation value of the stand is all that could be wished, as these species become merchantable in twenty-five to thirty years and pay good stumpage. A thick growth of cherry is absolutely worthless, and, what is more, keeps out all the valuable species for ten or fifteen years. A count of 2,116 wild red cherry seedlings was made on 1 square rod of a 1903 burn. This is equal to 338,560 to the acre.

When coniferous seed trees are adjacent to the burn, softwood seedlings begin to appear within five years at least. These are suppressed for a time by more rapid growing hardwoods, but if the land was originally of a coniferous type the softwoods will finally become dominant. On types approaching hardwood land the conifers will probably never return.

One square rod taken on an area burned eleven years ago, followed by another fire two years ago, had 22 popple and 122 cherry 2-year-old sprouts on it, averaging respectively 4 and 3 feet tall.

Sixteenth-acre plots, one on each type, gave the following results:

TABLE XXI.—*Reproduction on burned-over land.*

[One-sixteenth-acre plots.]

Species.	Slope, burned 12 years ago.		Flat, burned 30 years ago.	
	Number of trees.	Average height.	Number of trees.	Average diameter breast-high.
		Feet.		*Inches.*
Yellow birch	187	15	2	1.0
Sugar maple	123	3	.....	.....
Mountain maple	92	15	.....	.....
Wild red cherry	74	20	.....	.....
Spruce	.....	.....	22	2.5
Paper birch	.....	.....	20	3.1
Aspen	19	20	3	3.9
Balsam	1	1	18	4.2
Red maple	2	3	14	3.8
Striped maple	13	5	3	1.0
Mountain ash	5	15	.....	.....
Shadbush	.....	.....	5	1.0
Beech	1	1	.....	.....
Willow	1	15	.....	.....
Total	518	.....	87	.....

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TREES OF NORTHERN NEW HAMPSHIRE.

RED SPRUCE.

The red spruce is the characteristic tree of northern New Hampshire. It is found on all types and in a variety of mixtures. It occurs most frequently on a sandy loam soil with fair moisture content. It can not tolerate pure sand, as the white pine does, but it will grow on soil of scarcely any depth and in every variety of situation, from the banks of rivers to the mountain tops. On the best loamy soils it has been known to reach a diameter of 4 feet, breasthigh, and a height of 100 feet; the average mature tree, however, is about 18 inches in diameter and 80 feet in height.

In form spruce varies with age and situation. Trees in the open have long, conical boles, with lateral branches extending almost to the ground. In the forest the boles are more cylindrical, and a third or more of their length is clear. During the period of greatest growth spruce develops a long, narrow, conical crown, which in age tends to become broad and flat. The root system is very flat and shallow, made up of many small, branching, lateral roots. It is adapted to very shallow soils, but is not at all wind-firm.

Spruce produces some seed every year, but seeds very abundantly only about once in eight years. The seed does not germinate nearly so readily as that of balsam, and is more exacting in regard to the condition of the seedbed. Its requisites in this respect are (1) a suitable degree of moisture and (2) sufficient soil, either organic or mineral. There is no special light requirement. The best spruce reproduction is found where the above conditions are best fulfilled, and this is on old decaying logs covered with moisture-gathering moss. There is very little spruce reproduction on hardwood land, where the soil is covered with a thick matting of hardwood litter. On spruce flats and slopes the reproduction is generally good, as the ground is covered more or less with moss and there is considerable organic soil exposed. On the bare, moist mineral soil near streams there is often excellent reproduction. The seed is light and winged, and is easily carried considerable distances from the trees by the wind.

Spruce is one of the most tolerant of the coniferous species; that is, it can continue to exist with little sunlight, although it requires abundant light for rapid development. Germinating in the dense shade of the forest, it often continues to grow as a suppressed seedling for fifty years or more without reaching a height of over 5 feet. As soon as light is admitted, however, its rate of growth rapidly increases. It is this great tolerance and tenacity of the spruce in youth which makes up for its slow growth and causes it to be so generally distributed.

Spruce does not reproduce well on lumbered areas because the more rapid-growing hardwoods get in ahead of it and seed up the ground. On spruce land, however, there is usually sufficient young spruce already on the ground to take the place of that cut. This growth may be suppressed for a time by the hardwoods, but it will in the end form a large part of the stand.

BALSAM.

Balsam occurs in mixture with spruce throughout northern New Hampshire, and is found chiefly on the spruce flats, in swamps, and on the upper spruce slopes, often occurring nearly pure. It is not found to any extent on the hardwood land or lower slopes.

Very shallow-rooted, and needing only moss to germinate on, it can grow almost on the bare rock, and is the last form of tree growth to disappear on the summits of the high mountains, for it is found as a prostrate shrub at high altitudes. Balsam, at such elevations, rarely matures its seed, reproduction being dependent on seed blown up from below and on the layering of the trees themselves. Branches so layered are often found growing as independent trees, the connecting branch having decayed. The rooting always proceeds from dormant buds. Prostrate balsam occurs at an altitude of 5,500 feet on the Presidential Range, where it reproduces almost entirely by layering. At an elevation of 4,900 feet cones are borne sparingly, but even here reproduction by layering exists. The scrub form extends down to about 4,500 feet elevation, and the upper limit of merchantable size is at 4,000 feet (Pl. III, fig. 1).

Individual fir trees seed as a rule every third year. This is, however, varied in some cases by seeding in alternate years, and even in successive years. The more vigorous the tree, the more frequent the seeding. The pollen matures on the last year's shoot and the cones on that of the year before; thus in 1902, a good seed year, the pollen occurred on 1901 wood and the cones on that of 1900. The shoot made on the branches bearing pollen the year the pollen matures is usually markedly dwarfed.

The balsam prefers a mossy ground cover for a seedbed. Seedlings are usually very plentiful on old moss-covered logs and on the upper slopes. They are able to endure rather heavy shade, and will live for years in a suppressed condition, ready to start into active growth on the removal of the old forest. Reproduction is best on the spruce flats and the upper slopes (Pl. IV, fig. 1).

Balsam is not a long-lived tree; few individuals are found over 150 years old. It is easily thrown by the wind, and, growing as it does on very shallow soil at high elevations, the constant swaying of the tree in the wind may sever the connection of the rootlets, breaking and tearing them, and thus causing the tree gradually to dry out and die

for no apparent reason. Often large areas of such dead and dying trees are found on the upper slopes.

In second growth, balsam takes a prominent part, especially on flats and on the moister ground. It is also very common on old burns, clearings, and windfalls at high elevations, and with yellow birch often forms the chief reproduction.

While balsam occurs over the entire region, it reaches better development and forms larger individual trees in the upper Connecticut and Magalloway watersheds than farther south.

WHITE PINE.

White pine was originally abundant in New Hampshire, and was found in nearly all situations below 1,500 feet elevation. Practically all the old growth has been cut, and only a few scattered trees remain. The second growth, however, is good, particularly in the Saco watershed and the southern townships. The tree prefers a rather sandy and fairly moist soil, and has under favorable conditions an extremely rapid growth in height and diameter. Reproduction at present is confined almost entirely to old fields, which yield in thirty to fifty years almost incredibly large amounts of timber. In this length of time it is not rare for an acre of second-growth pine to produce 40,000 to 50,000 board feet.

The tree is intolerant of shade, and, chiefly for this reason, it thrives best in even-aged, pure stands, such as come up on abandoned land when there are seed trees in the vicinity. White pine is fairly free from injuries, although up to its fourteenth year it is susceptible to attacks from the weevil, which deprives the tree of its leading shoot. This injury, when prevalent, has serious results, producing distorted trees which are of little value.

RED PINE.

The red, or Norway, pine is most abundant in the Saco drainage basin, where it originally occurred mixed with white pine, or often in small pure stands. It is not found in the mountains, and only extends as far north as the lower Androscoggin. It prefers a sandy soil, such as that in Conway and Chatham, where it is most abundant (Pl. V, fig. 2). In both height and diameter growth it is very similar to the white pine, although having a slight advantage in early youth. It is not, however, quite as tolerant of shade as the white pine, and prefers a rather open seedbed. In abandoned fields and pastures it often comes in very densely. In habit it is gregarious, and is usually found in groups of a few trees or in pure stands over small areas. Restricted as it is to low localities with a sandy soil, it has not a wide distribution in the State, and is practically confined to the lowlands around the Saco. A few scattered trees are also found in the townships of Thornton and Warren and along the Mad River.

PITCH PINE.

Pitch pine occurs chiefly in the Saco watershed, on level, sandy soils. It is most plentiful in the township of Madison, around Silver Lake, and in the neighborhood of Ossipee Lake; Conway is its northern limit. It forms pure open stands, often with an undergrowth of barren oak (*Quercus pumila*) and some gray birch. It reproduces along roadsides and in openings in the woods, but requires a great deal of light. It resists fire remarkably well, often sprouting to some extent when burned. The greater part of the pitch pine land has been repeatedly burned over. Pitch pine never reaches a large size, although individuals are occasionally found 14 inches in diameter. It is usually short and stunted.

JACK PINE.

This species (*Pinus divaricata*), occurs on the rocky, thin-soiled slopes and summits of the small mountains in the southern townships. It is short and scrubby, and of absolutely no commercial value.

HEMLOCK.

Hemlock was formerly very abundant in the central part of the State, but has been almost entirely taken out for the bark. It occurs on the lower slopes of the Presidential Range below an altitude of 2,400 feet, and reaches its northern limit in the mountains of central Coos County.

Hemlock attains its best development on the lowlands along the streams and on the lower slopes, where it grows in mixture with hardwoods and white pine. The average diameter of mature trees is 16 to 20 inches, although many are found over 40 inches in diameter. Its growth is slow, and, although it is able to withstand very dense shade, the reproduction is very poor. The best reproduction is found along streams and in low, moist situations.

WHITE SPRUCE.

White spruce is found only in the northernmost part of the State, in the Connecticut Lake district. It here reaches its southern limit and replaces the red spruce to some extent in the forest. In height and diameter growth it is very similar to the red spruce, which it closely resembles in its characteristics.

BLACK SPRUCE.

Where spruce occurs in swamps it is usually not the red but the black spruce, which is better adapted to wet places. It is distinguished by its shorter and more scrubby development, darker bark, and a slightly deeper green cast of foliage. The cones also are smaller and more persistent.

LARCH.

Larch, or tamarack, is scatteringly distributed over the State, rarely occurring at elevations exceeding 1,300 feet. It prefers low, moist situations, where frequently the reproduction is pure and dense. The comparatively few swamps in the State explain in part the slight occurrence of the tree. It is one of the most intolerant species in the north woods, and, in the White Mountain region at least, is short-lived. It rarely reaches a diameter of 8 inches.

Larch is extremely sensitive to fire, a fact of which there are striking illustrations in the valley of the Israel River, in the township of Jefferson. Its chief enemy is the larch sawfly, which in the past has destroyed large areas of larch, but at present is not very much in evidence.

WHITE CEDAR.

White cedar, one of the less abundant species and one which rarely occurs in the southern part of the State, is the typical tree of the cold swamps in the north, where it frequently grows in dense patches. Ordinarily the size of the tree is small, 10 inches through and 50 feet high being unusual. Its reproduction is prolific wherever there is a suitable seedbed. This must be thoroughly moist and fairly deep. The seed is distributed to some extent by the agency of water. It is found on the shores of lakes and streams, and is common on Third Connecticut Lake, and also on the East Branch of the Pemigewasset River.

SUGAR MAPLE.

Sugar maple occurs over the entire State, and, with yellow birch, is the commonest of the hardwoods. It reaches its best development on the deep, fresh soil of the hardwood slopes, and is seldom found at elevations of over 2,600 feet. It never grows in swamps or on wet flats. It forms a long, clear bole, with a small crown, and reaches a maximum height of 90 feet and a diameter of 30 inches, although the average for mature trees is much smaller. Growing in a dense forest in mixture with spruce, yellow birch, and beech, it makes a heavy shade. In such places its reproduction is excellent; a thick matting of sugar maple seedlings covers the ground. It reproduces best on a seedbed of leaf litter where there is little underbrush. The seedlings are able to endure heavy shade.

Sugar maple is also very abundant along roadsides and on cut-over land. It is one of the first trees to come in after lumbering wherever the soil is sufficiently good to support it, and by its dense shade and faster growth during youth keeps out the softwoods.

YELLOW BIRCH.

Yellow birch has the widest distribution of any of the hardwoods in northern New Hampshire. It occurs in every situation from the

FIG. 1.—GROUND JUNIPER AND WHITE PINE COMING UP ON AN OLD FIELD.

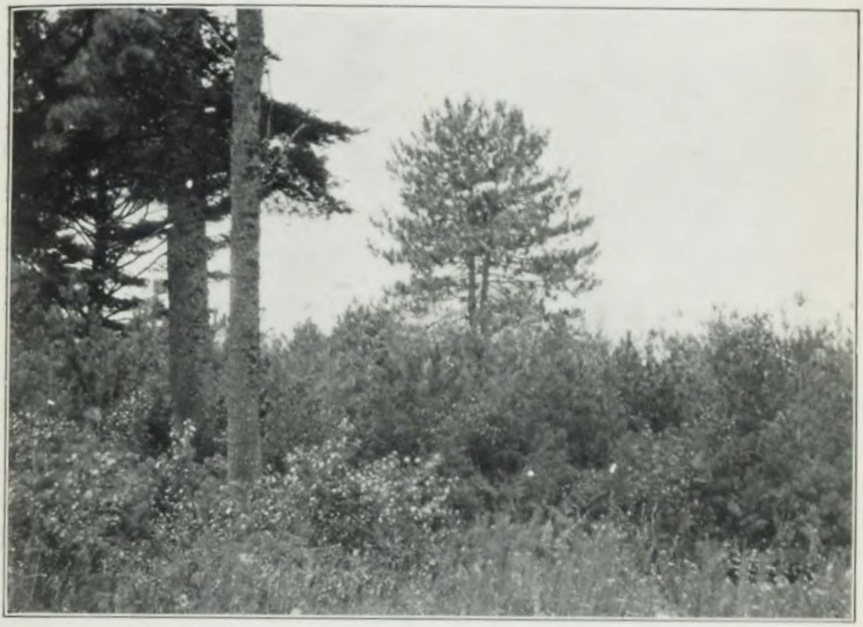

FIG. 2.—REPRODUCTION OF WHITE AND NORWAY PINE IN AN OLD FIELD NEAR SEED TREES, CHATHAM, N. H.

low, wet flats to the upper limits of tree growth on the mountains, but finds its best development on the lower slopes and drier flats, where it often reaches a height of 80 feet and a diameter of 36 inches. The trees of the largest diameter are, however, apt to be short, with wide-spreading or broken tops. The root system is shallow and well adapted to thin soil. Although the yellow birch will grow on rocky, shallow soil on the steep slopes, it is not found extensively above an altitude of 3,000 feet; individual trees, however, are common up to the limit of tree growth.

The yellow birch seeds abundantly, and the seedlings are able to grow in rather heavy shade, although they are not so tolerant in this respect as the sugar maple. The best seedbed is moss, old logs, and decayed stumps. In second growth and windfalls the yellow birch comes in very densely, often to the exclusion of other species, and, owing to its adaptability to all soils, forms a large part of the forest in every situation.

BEECH.

Beech occurs throughout the State. With sugar maple and yellow birch it forms the chief hardwood of the country. It grows best on the lower slopes and along the valleys and streams, and is rarely found above an elevation of 2,400 feet. On cut-over land it is very abundant, and after burns reproduces by sprouts. On the hardwood slopes, where it reaches its best development, it reproduces profusely, preferring a seedbed of mineral soil or leaf litter not densely overgrown with underbrush. Beech is very tolerant, equaling the sugar maple in this respect, and the seedlings are able to live in heavy shade.

The beech does not form a very sound tree in this region, and is apt to decay at an early period.

PAPER BIRCH.

Paper (or white) birch is widely distributed over the State, and is particularly abundant in the White Mountain region, where it occurs at all elevations from valley to timber line. Its occurrence above and below an altitude of about 3,000 feet presents a marked contrast. Up to this elevation it grows scatteringly, apparently crowded out by other hardwoods and spruce, all of which generally attain a greater height than the paper birch. Above 3,000 feet the tree vies with the balsam for the first place in the forest, where its white, exfoliating bark renders it the more in evidence. Its abundance at high elevations is due rather to the fact that the soil is too poor to support other trees than to its particular preference for such situations. At an elevation of 5,700 feet on Mount Washington it occurs as a prostrate shrub.

Paper birch attains its best development, however, in mixture with spruce at medium elevations, producing a clear merchantable stem topped by a comparatively short crown. Compared with its associating hardwoods it is short lived, generally evidencing a lack of thrift before it reaches its hundred and twenty-fifth year. Its reproduction in the forest at the lower elevations is noticeably scattering, which is explained by its intolerance of shade. At the higher elevations, however, where the other hardwoods practically cease and where the height of the tree has materially decreased, paper birch reproduces prolifically. On lumbered areas, burns, and windfalls the reproduction is frequently dense; this, however, depends upon the proximity of seed trees. It is not root-firm, and when a portion of the forest is removed it falls an easy prey to the wind.

RED MAPLE.

The red maple is abundant in New Hampshire. It prefers moist soils and is seldom found on the mountains above an elevation of 2,500 feet, although individual trees are occasionally seen at 2,700 feet. It is one of the commonest trees on cut-over land at low elevations, and is very conspicuous in second growth, owing to its ready tendency to coppice. The red maple reproduces easily. It is not so tolerant of shade as the sugar maple, but makes rather faster height growth.

POPPLE AND ASPEN.

These two species (*Populus grandidentata* and *Populus tremuloides*) have practically the same silvicultural characteristics and commercial value. They differ slightly in distribution, popple, or large-tooth aspen, being confined mostly to the southern half of the State, while aspen has a general distribution over the entire State.

Popple is extremely rapid growing, but short lived. It shoots up like a weed, growing on the average 18 feet in height in the first eleven years. It will not grow on the poorest qualities of soil, and is generally found in the better localities. The aspens have a light-winged seed that can be easily carried for long distances by the wind, and any land is apt to be seeded up to a thick stand of these species wherever there is sufficient light, as on burns, after lumbering, or on abandoned fields. The trees seldom get beyond 50 years in age, by which time they have reached a large size. Extreme intolerance of shade is usually, however, the cause of their early death. Commercially, popple is a valuable tree. Its use is chiefly for soda pulp and excelsior. After fire or lumbering, the aspens are very desirable species to have come up, as they become merchantable in twenty years and yield a large amount of wood to the acre.

WILD RED CHERRY.

Wild red, or bird, cherry (*Prunus pennsylvanica*) is the common successor of fires, and comes up with great energy, especially where the land has been burned over more than once. It is fast in growth, but never reaches large size, and is absolutely worthless. The densest stands are to be found on Cherry Mountain and in the Zealand Valley, in the townships of Carroll and Bethlehem, and on Pine Mountain in Gorham. All these tracts have been repeatedly burned over. It occurs over the entire State, coming up on old logging roads and on cut-over land, but to attain its best development requires fire.

The seed are almost wholly distributed by birds, which are very fond of the fruit. The seed may remain in the humus for long periods before germinating. When a fire runs over the area all seeds not killed are brought into direct contact with the capillary moisture of the mineral soil by the burning away of the organic matter on which the seed rested. The seed coat is very thick and so is able to withstand a very hot fire, while considerable moisture is required to start germination. The access of light that follows a fire or cutting is also necessary, for the cherry is very intolerant of shade.

After a fire practically every uninjured cherry seed that is properly covered by soil germinates, and makes a very rapid growth the first year, having, in the case of a severe burn, little or no competition. A height growth of 3 or 4 feet and even more is common. If the area is again burned over, each seedling sprouts with great energy. The result is a dense stand of wild red cherry. Though it grows very rapidly at first, its height growth is limited, and at the end of thirty years becomes very slow. Other species then quickly crowd it out. Few trees over 50 years old are found.

WHITE OAK.

White oak, though common in southern New Hampshire, occurs in the region examined only as scattered individuals over a small area. It extends as far north as Plymouth, Squam Lake, and the Ossipee Lakes, but is seldom found at an elevation of over 500 feet, and in the section of the State examined is a tree of merely botanical interest.

RED OAK.

Red oak also is a typical tree of the southern part of the State. It is the hardiest of the oaks, and extends as far north as the Israel River on the east and the lower Androscoggin on the west, but is not found in the White Mountains proper. It is most abundant in the townships of Warren, Wentworth, and Rumney, in the Pemigewasset watershed, where it forms a large part of the hardwood forest.

In the township of Eaton, on the slopes north of Robertson's pond, it occurs as an almost pure stand, with some ironwood in mixture. It is common on Mount Hayes, in Gorham, up to an elevation of 2,500 feet, but is not usually found at such elevations, rarely occurring in large numbers above 1,500 feet.

The red oak sprouts readily, and is fairly tolerant of shade.

WHITE ASH.

White ash, scatteringly distributed in the region considered by this report, exhibits a marked increase in occurrence and size from north to south. It generally seeks moist alluvial soil along streams, but was found, though as a straggler, at an elevation of 2,300 feet on Mount Hayes, in the township of Gorham. In the White Mountain region specimens of large size are uncommon. Though the tree sprouts freely at the stump, reproduction from seed is poor. Intolerance of shade is a characteristic of the white ash, and becomes more pronounced with age.

BLACK ASH.

This species occurs in moist situations below 2,000 feet elevation. It is found in the valleys where the soil is fertile and deep, and along small streams. It is not of frequent occurrence.

ELM.

The white or American elm, although of wide distribution and common over the entire State, does not occur anywhere in great abundance. It is found on deep alluvial soils along the streams and in meadows, but is not found to any great extent in the forest. Owing to its requirement for deep, moist soil it occurs only at low altitudes.

BLACK CHERRY.

Black cherry is not common in northern New Hampshire, and no large trees are found. It reaches its best development on fresh, deep soil, and on the lower slopes and valleys. It occurs chiefly as individuals along roadsides. It was found in greatest abundance at low elevations in the townships of Chatham and Eaton and along the Androscoggin. The reproduction is very poor, and but few seedlings are found.

GRAY BIRCH.

Gray birch, often called "white birch," but to be distinguished from the paper or white birch, has about the same distribution as white pine. It occurs plentifully in the southern townships of the State, in fields and pastures. It is of little commercial value except for cordwood.

BLACK BIRCH.

Black birch occurs but seldom in the region examined. It is found chiefly on the small mountains in the southern townships, but rapidly disappears northward. It prefers moist, cool situations.

BASSWOOD.

This species is often found in hardwood forests under 2,000 feet in elevation in the southern half of the State. It prefers moist, well-drained, fertile soils, and is not common in northern New Hampshire.

BUTTERNUT.

Butternut is chiefly found in the southern part of New Hampshire, and occurs only as scattered individuals in the northern townships, in fields and along roads. It is of little commercial value.

TABLE XXII.—*Average height of the important species.*

Diameter breast-high.	Spruce.	Balsam.	Sugar maple.	Beech.	Yellow birch.	Paper birch.
Inches.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
6	41	46	46	53	45	48
8	49	53	53	59	51	56
10	55	59	57	63	56	61
12	60	63	59	65	58	63
14	64	67	60	67	60	65
16	67	70	61	68	61	67
18	70	73	62	69	62	69
20	73	76	63	70	63	72
22	76	78	64	71	64	74
24	78	80	65	72	65	76

FOREST FIRES.

The general topography of New Hampshire is sufficiently hilly to preclude the possibility of a catastrophe by fire commensurate with that which occurred in the Miramichi Valley of New Brunswick in 1825, or in Wisconsin and Michigan in the early seventies. Forest fires, however, of greater or less extent and severity have been the common accompaniment of lumbering and the clearing of land since the earliest days. In recent decades the introduction of the steam railroad as a common carrier and as an adjunct to the lumberman's logging outfit has greatly increased their number. The same is true of the increase in the number of persons who frequent the woods for pleasure. The extension from year to year of the total area which has been burned, together with the facts that the great bulk of this land has failed to develop a valuable forest growth, that

indeed much of it remains an absolute waste, and that the forest resources of the State are being rapidly depleted, has forced on all thoughtful persons interested, financially or otherwise, the recognition of the fire question as the question of first importance to the forests of the State.

EXTENT AND DAMAGE.

For a number of years preceding 1903 New Hampshire was comparatively free from destructive fires, although almost every year added a considerable, and some years a very large, contribution to the total area burned over. These fires ran as a rule over lumbered land, but occasionally they destroyed considerable areas of virgin forest. One of the most destructive of them within the White Mountain region was that in the Zealand Valley in 1888. This valley had been lumbered for spruce saw timber, the spruce being taken to a diameter of about 10 inches on the stump. The fire, starting, as is supposed, from a burning match dropped by a smoker, ran over some 12,000 acres, destroying the hardwoods and the remaining spruce, together with about 2,000,000 board feet of sawlogs on the skidways. The loss in stumpage was estimated at the time at $50,000 on the pulpwood standing. The hardwoods had at the time practically no sale value. One hundred thousand dollars would be a conservative estimate of the present stumpage value of this spruce had it not burned, without taking into account the value of the large growth increment which would have accumulated during the fifteen years since the fire.

In 1903, 84,255 acres were burned over. The amount of damage varied greatly in different localities, but a conservative estimate would place it at something over $200,000. The spring of 1903 was particularly favorable for forest fires. The precipitation between April 17 and June 6, in the White Mountain region, averaged about 0.3 inch, as compared with 5 inches normal rainfall for this time. The winds averaged somewhat above the normal, and the same was true of the percentage of sunshine, all combining to bring about a season of unprecedented danger. New Hampshire suffered greatly in destruction of her mountain soils. The loss of stumpage, however, considering the area burned over, was inconsiderable, while the loss to settlements was fortunately very slight. In the latter respect New Hampshire has been very fortunate, for although vast property interests have been threatened in her forest fires, comparatively little burning of buildings or improvements has taken place.

In injury to standing timber the loss has been far greater. The amount of injury done in any particular case depends on the character of the stand and the intensity of the fire. The latter, in turn, depends on a variety of circumstances, chief among which are the velocity of the wind at the time, the gradient and exposure of the

area burned, the character of the ground cover, the moisture conditions, and the start the fire has got.

In this connection the effect of the elevation on the wind velocity is of importance. It is well known that normally the air movement increases very markedly with increase of elevation above the earth's surface. The result of this increased air movement depends very largely on the total height, gradient, and form of the hill, and to a still larger extent on the height of the neighboring hills. The data taken at different points on Mount Washington by the United States Weather Bureau indicate an increase of about 9 or 10 per cent in the wind velocity per 100 feet increase in elevation. This may be regarded as approximately correct for unsheltered hillsides; but at the comparatively low elevations at which most fires originate the increase is in almost all cases very much greater. Fires from railroads, fishermen, and campers originate, as a rule, in valleys, where at 100 feet elevation on the leeward side the wind velocity may be easily double or treble that obtaining where the fire started.

Exposure and gradient also play a considerable part in determining the severity of the fire. In general, south and west slopes and slopes which face the prevailing winds are more apt to be visited by severe fires than those less exposed to drying influences. Especially important is the exposure of a hillside in relation to the direction of the wind at the time of the fire. The more nearly a slope faces the direction of the wind, the more favorable the chances for the development of a severe fire, and the steeper the gradient, the more rapid and the more complete will be the conflagration.

SURFACE FIRES.

In light surface fires the most important consideration is the character of the ground cover. In pine forest the inflammable character of the dead needles which cover the ground makes such surface fires very likely to occur, especially in April, with its light rainfall and high winds. On hardwood lands the débris is normally much less inflammable than under pines. In early spring, however, when the rainfall is light and the winds are high, the fact that the trees are without foliage makes the danger of ground fires here second only to that on pine lands, the absence of foliage permitting direct drying and heating by the sun's rays and giving the wind a much more effective sweep. These surface fires may spread quite regardless of the moisture condition of the soil, and are sometimes to be seen running over the ground in the immediate neighborhood of banks of yet unmelted snow, so effective are wind and sun, during the long days of the latter part of April and May, on the unshaded floor of the hardwood forest.

These surface fires are, as a rule, more injurious to the prospect of future crops than to the mature timber of the stand. They are, nevertheless, always more or less injurious to the mature timber. The various hardwoods as well as spruce and balsam are frequently injured by the death of the bark in spots at the base of the trunk or on a root. This, in the case of the hardwods and balsam invariably, and with the spruce usually, results in defective timber, the injury providing a favorable opportunity for attack by the wood-destroying fungi. The growth of the stand is checked by the destruction of the mulch of leaves which is nature's protection against direct evaporation of moisture from the surface of the soil and against the development of moisture-robbing weeds on the forest floor. The stand suffers also by the deterioration in the fertility of the soil due to the destruction of the humus.

Should the soil itself be dry, the results are at once more evident and more serious. This is due to the fact that forest soils normally contain a sufficient amount of organic matter to burn more or less deeply in a dry season. This soil burning varies in severity according to the depth of the organic matter, the dryness, etc., but is very destructive to standing timber even when comparatively slight. Trees having a superficial root system are naturally the greatest sufferers.

Such fires may, when drought has not been excessive, or before the ground has become very dry, kill the timber in spots only, burning superficially or not at all over the remaining area. Such fires are often not regarded seriously because of the small proportion of the total area injured. They sometimes prove, however, almost as disastrous in the end as a more general burning, for the places where the trees are killed make very favorable points of attack for both wind and insects.

A severe surface fire will certainly kill all the standing timber, and may ruin the soil (Pl. VI, fig. 2). It will not, however, destroy the timber which it kills. This timber may be saved, if removed during the same season, without injury to its quality or value, aside from any inconvenience arising from the necessity of its utilization at once. A crown fire, on the other hand, such as is likely to occur in coniferous stands under favorable conditions, almost invariably injures the market value of the timber, and may consume the trees altogether.

FIRES IN VIRGIN FOREST.

On virgin hardwood land, fires are not of frequent occurrence, and when they do occur they are usually of the light surface type. Virgin spruce lands in New Hampshire have not suffered greatly from fire. Occasionally fires from cut-over lands, driven by strong winds, have caught in the tops of virgin spruce and swept over considerable

FIG. 1.—NORTH SUGAR LOAF MOUNTAIN, NEW HAMPSHIRE.

Once heavily timbered, but now practically barren, as a result of clean cutting and fire.

FIG. 2.—YOUNG CONIFERS KILLED BY A SEVERE GROUND FIRE.

areas. Ground fires resulting from carelessness of campers and other causes have been known, after days of slow burning, to develop under favorable conditions into fierce conflagrations. Such a fire was that which destroyed the virgin spruce and balsam stand in King Ravine, on the north slope of Mount Adams.

FIRES ON LOGGED LANDS.

Fires on cut-over lands of all kinds present much the same characteristics. Once a fire gets a start on such lands, with wind and weather at all favorable to its spread, it is usually quite impossible to combat it with any success. Where the cut has been heavy and the resulting débris correspondingly large, all the difficulties of fire fighting are proportionately increased. All kinds of waste material left in the woods supply food for the flames, but the leaving of large, unlopped softwood tops on the ground adds enormously to the fury of a brush fire and greatly prolongs the length of time that a slash remains a menace to its own and surrounding areas. These large tops, propped up from the soil by their branches, are very slow to decay and become very dry. A large area in the Zealand Valley which escaped the fire of 1888 was burned over in 1903, eleven years after the last lumbering. This valley had been lumbered for spruce sawlogs only, no trees under 10 inches on the stump being taken. This fire, which ran over about 10,000 acres, shows that the length of time that cut-over areas must be specially protected against fire is great, even when a very considerable proportion of the stand is left after logging.

Fires on cut-over lands usually kill all standing timber left on the area burned, as well as all the young growth. Until market conditions shall make it possible greatly to reduce the amount of waste material which is at present left on the ground after the average lumber job, the only safety for such lands is in an efficient fire patrol during the dangerous season. Unfortunately the owner of lands severely cut over usually has not, or thinks he has not, a sufficient financial interest at stake to provide for this. This circumstance and the fact that the State has the greatest interest in the protection of the land for the production of crops which shall be harvested by a succeeding generation, point to the desirability of its providing such patrol, toward defraying the expense of which taxes on timberlands may well be made to contribute.

FIRES AND FUTURE CROPS.

The influence of fire on the production of future crops of timber has chiefly to do with the change brought about in the species present and the effect of burning on the soil capacity. Of all the influences affecting the distribution of forest trees in New Hampshire within the last

century, no other has produced anything like so profound an impression as fire. The magnitude of this change depends naturally on the character, especially the severity, of the burn. Even a slight surface fire is exceedingly destructive to young growth and to the seeds of trees which may be present in the soil covering. Naturally some species are more susceptible to injury by a very light fire than others. This gives the species that is the most resistant a very decided advantage over the rest. Hardwoods when burned over will generally sprout, and this gives these species a tremendous advantage on burned areas.

The influence of fire on the soil is due almost wholly to the destruction of the humus and other organic matter in it. The importance of the accumulation of organic matter as a constituent of forest soil can hardly be overestimated. Where least important, on deep, rich soils, it still serves as a mulch on the surface to prevent direct evaporation of moisture. Its presence also greatly increases the moisture-holding capacity of the soil by increasing both its hygroscopic and its mechanical retaining powers. It also acts as a fertilizer. The burning of this humus liberates the nitrogen of the organic matter as free nitrogen, thereby destroying absolutely the most valuable plant-food constituent contained in the soil. The potash and phosphoric acid compounds, which stand next in importance, are mostly converted into soluble salts, which are very rapidly leached away by succeeding rains.

The importance of the humic content of the soil increases with increasing gradient. In fact, it is the only thing which makes the presence of forest growth on the steeper mountain slopes a possibility. This is true elsewhere than under the extreme conditions of high altitudes, where the trees are short and scrubby, although here, to be sure, the fact is more evident. On many slopes bearing the finest spruce the presence of any forest growth whatever is due to the accumulation through the ages of a mass of organic matter which held the mineral particles of rock as they were gradually disintegrated, preventing their being washed to the bottom of the slope. The soil that obtains to-day on such areas is very largely organic matter, and when fire-swept, if dry, is so nearly consumed, especially by repeated fires, that the remaining mineral particles heretofore held firmly for perhaps thousands of years are, together with the ash resulting from the burning of the organic matter, washed away until nothing but bare rocks remain. Many hundreds of acres of such lands are to be seen in the White Mountain region of New Hampshire. In some cases the trunks of trees upward of a foot in diameter remain standing on the barren rocks from which every other sign of a former and every hope of a future timber growth has been burned and washed away.

After a severe fire on these steep slopes, the intricate network of fine rootlets which constitutes the major part of the humus having been burned, the rain falling on the bare soil quickly carries away in solution not only all the soluble mineral plant food liberated by the fire, but also the finest and most valuable particles of the soil itself. The extent to which this erosion may be carried depends on the amount of precipitation, the character of the soil, the gradient, and the length of time before new growth starts. The leaching out of soluble plant food and the washing away of the finer particles of the soil may continue, however, long after the slope has again become covered by vegetation. Slopes of this type, owing to the rapidity of the erosion and the slowness with which they become reseeded to forest trees, are usually lost to forest production.

CHARACTER OF GROWTH FOLLOWING FIRES.

Trees and other plants have different ways of gaining a foothold on a burned area. A few species produce seed that is capable of a greater or less resistance to fire. Some seed finds safety by being deeply imbedded in the moss, which is rarely completely consumed over the entire area. The greater number, however, are brought in from neighboring areas by the agency of wind or animals. If the soil has not been deeply burned, most of the hardwoods will sprout from the root collar. Some, even when the soil is very severely burned, are capable of sprouting from portions of the roots which may have escaped death. Among herbs the development of shoots from roots and root stocks is by far the most common mode of reproduction after a fire.

Of the species whose seed is able to survive a considerable degree of heat, wild red cherry and the common raspberry are the most noteworthy. The sumach (*Rhus glabra*) also comes up after fires from seed already in the ground, but it is of only local distribution. The seed of the wild red cherry is by far the most resistant, and survive wherever the humus is not entirely destroyed.

The wild red cherry, therefore, by virtue of its presence on the ground and readiness to germinate as soon as the fire is over, together with its vigorous growth the first season and the fact that its best development takes place in direct sunlight, is one of the most characteristic features of the new growth on recently burned areas. Should the burned area be in close proximity to land previously burned and now covered with cherry trees bearing fruit, the number of seedlings of this species which will spring up on the new burn will be very great. Birds, after feeding on the cherries, drop the seed in the forest, and when this is cut or burned over, the seed, unless killed, germinate at once. As many as 1,200 of these cherry trees have been

counted to a square rod. Where the growth is anything like so dense all other growth is for a time excluded, until some shade-enduring species gets a foothold under the cherry.

Yellow and paper birch seed occasionally survive a fire when they are well embedded in moss, but they are usually carried in after fire by the wind.

The aspen (*Populus tremuloides*) and popple, or large-tooth aspen, (*P. grandidentata*) are characteristic features of the growth following burns. The former is by far the more common on the poorer soils and higher elevations, while the latter is more at home on the deeper, richer soils of the valleys. The seed of these trees is wholly dependent on the wind for distribution. That any seed present before the fire should survive is highly improbable, as a simple drying destroys their vitality, and their appendages would prevent any deep penetration of the moss where they might find safety. The willows resemble the popples in time of maturity, distribution, and germination of their seed, and are frequently found on burns. The species which occur are of no commercial and little silvicultural significance.

When the burning of the soil itself has not been sufficiently severe to kill the roots of the trees, reproduction by sprouts from the root collar of the broad-leaf trees usually occurs. The resulting stand is at best very inferior. In many cases it is largely composed of mountain and striped maple, and pure stands of the former are sometimes seen, although wild red cherry generally forms a large part of the growth.

REPRODUCTION AFTER FIRES.

The reappearance of conifers on burned areas is entirely dependent upon the presence of seed trees sufficiently near to admit of the blowing in of the seed. It is of interest to note that where seed is available the spruce reproduces best where the soil has been most thoroughly burned; that is, where the seedlings have the best opportunity to reach the mineral soil at once. Balsam, on the other hand, prefers to germinate on a mossy spot. The result of this is that on land thoroughly burned and afterwards well seeded by spruce and balsam the former will usually outnumber the latter fully fivefold in the succeeding growth, while on a mossy seedbed the balsam reproduction far outnumbers the spruce. These conifers, however, seldom appear on a burn in large numbers, being crowded out by the faster-growing hardwoods which occupy the ground first. They come in slowly under the shade of the latter, and gradually become a part of the stand. The spruce and balsam remain, as a rule, under the shade of the popple sufficiently long to permit the latter to develop to a merchantable size before its ascendency is threatened. Where the land has grown up to a broad-leaf coppice, as on hardwood

FIG. 1.—LAND CUT CLEAN AND BURNED OVER TEN YEARS AGO—NOW COVERED ONLY WITH ASPEN, WHITE BIRCH, AND WILD RED CHERRY.

FIG. 2.—FOREST CUT TWENTY YEARS AGO TO A DIAMETER LIMIT OF 14 INCHES—NOW READY FOR ANOTHER CUTTING.

land, in which the maples, beech, or yellow birch are prominent, the conifers make little headway, and a pure hardwood forest is the inevitable result.

On pine lands a single fire is less serious than in any other type of forest. The soil rarely burns deeply enough to kill the roots of the mature trees, and their fire-resisting bark protects them above ground. The soil is not usually liable to excessive erosion after these fires, because of the slight gradient. In most places there is very little of the undesirable undergrowth which springs up with renewed energy after every fire. The chief effect is the killing of all softwood reproduction and seedling growth. Repeated burnings are, however, common on the sandy plains, and where this occurs no reproduction can take place, and sand barrens with a few scattered scrubby pines are the result. On the pitch pine areas near Silver Lake repeated fires have occurred, and there is now a dense ground cover of worthless barren oak, which prevents all other reproduction.

On much of the burned area in northern New Hampshire fires have occurred more than once. The tendency of a repeated burn is to increase the number of hardwoods present. Wild red cherry and the popple, when burned, sprout freely from the roots, or even from parts of a root that is burned through in places. The number of sprouts usually exceeds the number of trees in the stand before the fire. Neither of the above species gains any advantage over the other by repeated burnings when two or more years elapse between the fires. When, however, fires follow each other in successive years the popple is almost totally destroyed, while the cherry sprouts as vigorously as ever. The practical extermination of the popple on several different areas in the mountains is traceable to this cause. Almost the entire growth of popple and wild red cherry after second and subsequent fires is by sprouts. Any popple seed which may have blown in is at too great a disadvantage in competition with the coppice and weed growth. The same would be true of cherry seedlings, but as those first established have not, as a rule, reached fruiting age between the fires, and as birds would not frequent the area, it is improbable that any seed of the cherry is available.

Seedlings of paper and yellow birch rarely come in after a second fire. If the second burning is light, the birch will reproduce vigorously by shoots from the root collar; if severe, the area is usually practically destitute of birch reproduction.

Light subsequent fires on sprout land do not materially change the composition of the stand. The growth of the intervening years is, of course, lost, the trees being killed to the ground. In the subsequent sprouting the number of sprouts will probably be increased, but with a corresponding decrease in their prospective value. The latter, however, is not serious, for little else than firewood can be expected. But

it must be remembered that with each repeated burning the softwood species are killed, and the chance of their appearing in the new growth is materially lessened.

The development of herbaceous growth, which is uniformly an accompaniment of repeated fires, is one of their most serious features. The soil, after it has once been thoroughly depleted of its organic matter, is never burned sufficiently deep by subsequent fires to destroy the roots and root stocks of the perennial herbs and grasses which have found their way in. The result is that with each succeeding fire the possibility of reproduction by seed of any valuable forest tree becomes more and more hopeless, and the land is with each burning given over more completely to inferior sprout and weed growth. The chief perennials which are found on such lands are raspberry, fireweed, blueberry, sorrel, pigeonberry, blackberry, golden-rod, and brake fern.

CAUSES OF FIRES.

The principal causes of forest fires, in the order of their importance, are railroads, carelessness in clearing land, fishermen and campers, and malice.

Railroads undoubtedly set very many more fires than are due to any other single source. That the aggregate amount of damage done is very great can not be better illustrated than by the fact that a division superintendent of a railroad operating in the White Mountain region had in his office on September 12, 1903, 554 separate reports of fires causing a greater or less amount of damage to neighboring property during the season of 1903. These fires originate either from sparks from the smokestack or from hot coals dropped from the ash pan. That this latter method is a very effective way of setting a fire was well shown at Carroll in July. An express train, in rounding the curve at this point, dropped a quantity of glowing coals, some of which were thrown as much as 8 feet beyond the rail by the centrifugal force exerted as the engine rounded the curve, and instantly started a number of fires in the grass and litter for a distance along the line of more than 40 yards.

Fires from coals from the ash pan are invariably near the track, and are usually at once conspicuous. Those originating from sparks from the smokestack may occur at a considerable distance from the track, and may smoulder for a long time before being discovered. On this account they are more dangerous. They are also probably more frequent. There seems to be no entirely satisfactory spark arrester on the market, but that the danger can be very greatly lessened by the use of the best one available is certain. There can be no excuse for the dropping of coals from the ash pan when the train is running at high speed. This is simply a matter of carelessness.

The substitution of oil for coal as a fuel for locomotives or the use of electric motive power would mean absolute safety. The success of the former on an Adirondack railway and the very marked reduction in operating expenses by the latter substitution on the lines of a New York rapid transit company commend them to the consideration alike of the railroad companies operating in the forest lands and to the State legislators.

Among the numerous causes of forest fires the getting beyond control of fires set for the purpose of clearing land occupies a prominent place. There are many persons among the farming community who do not appreciate the danger of burning brush in the neighborhood of woodlands during a dry time. Unfortunately the danger from this source is not due entirely to ignorance or simply to thoughtlessness. There are many persons who will not consult the safety of their neighbors' property in this matter, even if the danger has been clearly pointed out. The evil clearly calls for both educational and restrictive measures.

Fires caused by fishermen and others who build camp fires in the woods are not infrequent, and many of the most disastrous fires have been attributed to this cause. It is a common practice for fishermen to build fires for warming coffee, etc., or to keep away flies and mosquitoes. Many who indulge in this practice have little or no knowledge of the precautions to be observed in kindling and extinguishing fires in woodlands. This is more serious in the case of fishermen than in that of most other campers, because of the fact that the best fishing season happens to be at the time of year when the danger of forest fires is most imminent. The places where these fires are kindled are usually far away in the woods, and are not infrequently in obscure places along small streams where it is very improbable that they will be seen, and then probably only after they have got beyond control. It is not surprising, therefore, that timberland owners dread the camp fires of the fishermen perhaps more than any other cause of fire, since it is one of the causes over which they have no control and for the damage from which there is no recourse in case of loss.

Among the minor causes of fire, carelessness of smokers in dropping burning matches and cigar stubs probably takes first place. The setting of fires to improve the berry crops is also of not infrequent occurrence. Fires are also occasionally set for revenge, or out of pure maliciousness.

DANGEROUS SEASONS FOR FIRES.

In New Hampshire there are two seasons when the danger of forest fires is much greater than at other times. The first and most dangerous fire season is due to begin soon after the snow melts in the spring, and continues till the leaves come out. The second begins about the middle of September, and continues till the last of October. These

dangerous seasons are due to a combination of meteorological and physiological conditions. The meteorological conditions, in the order of their importance are rainfall, air movement, humidity, sun, and temperature. The physiological conditions are the opening and the fall of the leaves and the springing up and maturing of the herbaceous vegetation.

The physiological factors vary but slightly from year to year, and then only in regard to the time of their occurrence. The conditions which produce drought are much more variable. Thus, while there are two especially dangerous seasons, other periods of danger may develop should a very abnormal deficiency in rainfall occur; and while the two danger seasons normally begin and end at the time mentioned, either may begin or end earlier or later, according to the weather and season. In some years there may be no danger season at all.

The humidity of the atmosphere has a very important bearing on the fire seasons. The lower the humidity the greater the absorption of moisture from the forest floor by the atmosphere. April has an extremely low relative humidity, and May and even June are both below the average. The rainfall in the spring months is also below the average. April has an average precipitation of less than 2.1 inches, as compared with nearly 4 inches in the month of August. May has a fair rainfall, but also below the average, while the wind movement for these months greatly exceeds that in the summer. The absence of green herbaceous growth on the ground, and of leaves on the broadleaf trees, allows the full sweep of the wind and the heating and drying of the leaf litter by the direct rays of the sun. With the increased rainfall in June and the development of the leaves, the danger season passes away, and during the summer months fires are the exception rather than the rule.

The fall fire season, although rarely as dangerous as that of the spring, frequently witnesses very disastrous fires. The rainfall of about 4 inches in August decreases to a little over 3 inches in September, and to still less in October, which ranks as one of the driest months of the year. The air movement meanwhile increases from a minimum of 140 miles per day in August to 175 miles per day in October. The leaves also are rapidly falling, and herbaceous vegetation is for the most part mature. The conditions, therefore, closely resemble those in the spring, although not quite so extreme.

PREVENTION OF FIRES.

The prevention rather than the extinguishing of fire must be the object of any successful attempt at fire protection, and on the success which it meets depends the possibility of forestry, and with it the possibility of continued lumbering.

Fire protection is essentially a function of the State. The utili-

zation of the township as a working unit for fire protection has been tried in many States, with little or no success. New Hampshire not being a land-owning State, the direct loss in stumpage values by fire falls wholly on individuals and lumber companies. It is nevertheless true that such loss is essentially a State loss. The destruction of the soil by fires that follow lumbering may not greatly concern the individual who owns the land, but who does not hope to live to reap a second crop. To the State, however, it is of first importance that the natural resources represented by the soil capacity should not be impaired or destroyed.

This consideration points to a duty on the part of the State to organize and direct the work of fire prevention and fire fighting. The first duty of the State in this direction is to educate public sentiment concerning the seriousness of the fire question and to inform the public in regard to fire laws, but it should also maintain a force for the prevention and fighting of forest fires. It is worth consideration also whether the State may not fairly require reasonable precautions to be taken by forest owners to prevent the existence of conditions which constitute a menace to surrounding property. The funds for such protection might be obtained by an increased tax on cut-over land where much timber has been removed, as here danger from fire is greatest. The taxes on the land might very properly be remitted partly or altogether when the owner provides for fire protection to the satisfaction of the chief fire warden. So thoroughly alive are the lumbermen of New Hampshire to the necessity and value of efficient fire protection that no serious objection to a tax of this kind is anticipated. Should such develop, however, it is evident that if the lumbering of forest areas is not yielding a sufficient profit to the operators to enable them to pay without hardship half the cost of protecting themselves and the community from the danger created by their operations, it is not good policy that the lands should be lumbered, and the tax would then serve the valuable function of conserving the forests until the stumpage value advanced sufficiently to pay for the risk incurred by the lumbering. The exact amount of this tax can be easily adjusted to suit the requirements of the service.

Considerable areas of forest lands in New Hampshire are held by hotel companies, which are especially interested in the prevention of fire in their neighborhood. It is very possible for such companies to provide for a system of trails covering the tract, which could at any time be utilized as a means of communication and transportation between headquarters and a point of danger. In an emergency they could be used as fire lines, and at other times they would provide pleasant walks for the guests. Should a railroad pass through the tract, a trail should parallel it on either side at a distance of about 50 to 75 feet from the track, and all brush and other débris between

the trail and the railroad should be piled and burned at a safe time. Where feasible, trails should follow the crests of any low ridges, which are particularly favorable places at which to make a stand in fighting fire. A number of the trails should be sufficiently open to admit of transportation of tools and provisions by pack horses, and all should be carefully mapped. In the building of such trails old logging roads should be utilized so far as possible. They can be very cheaply transformed into excellent paths, and make very effective fire lines.

The extensive use of the steam railroad in logging operations in New Hampshire calls for some special attention in connection with this subject. A number of the lumber companies using this means of transportation are exceedingly careful in their management, and have been very successful in the prevention of fires. The chief points to be observed may be briefly specified. A strip about 30 feet wide on each side of the track should be cut clean and all brush carefully burned. The grass and weeds should be cut on this strip at least twice during the season and removed or burned. A strip of forest land about 300 feet wide should be left untouched on each side of the track between the cleared strip and the area where logging is carried on. The timber on these strips can be taken quite as satisfactorily at the end as at the beginning of the job, and they provide, at no cost whatever, a very effective fire line.

Water barrels should be placed at frequent intervals. These may be filled from the engine tank. They provide a supply of water for the patrol who should follow up the train during a dry time.

The patrolling of the line during the danger season is of the utmost importance. A four-wheeled railway bicycle is very convenient for the purpose. The patrol should follow up every train during the dry season, extinguishing any incipient fire with a pail of water, which is carried on the hand car and which can be replenished from time to time from the barrels along the track.

A long hose which can be attached to the engine tank should be available. It is very useful in wetting out a fire near the road, that is under control but smoldering in a duffy soil.

The use of the most approved spark arresters and devices to prevent the dropping of coals from the ash pan is, of course, of primary importance. The use of coal in preference to wood for fuel is good fire insurance, even when the extra cost is considerable. If the season is especially dry it may be necessary to run the engine at night only, or to discontinue using it altogether until rain falls.

METHODS OF FIGHTING FIRES.

Promptness of action on the discovery of a woods fire is quite as essential to success as in fighting any other kind of fire. Should a fire be spreading, the most essential thing is to stop it. This may

often be done by vigorously beating it out with spruce or balsam boughs. If water is at hand, that is, of course, the next resort. A hoe, spade, or shovel may be used to excellent advantage in throwing mineral soil from in front on the burning margin. This checks the flames, and at the same time makes more or less of a fire line. Having stopped the spread of the fire, a fire line must next be made around the area by the removal of any inflammable material from a narrow strip, after which attention may be given to the extinguishing of the fire on the area itself. If water be at hand it will greatly simplify the matter; if not, the only recourse is to bury the burning matter with mineral soil.

Aside from fires on cut-over lands, where large quantities of brush make it possible for a fire, once well started, to run at any hour of the day or night, forest fires do not usually begin to run until about 10 o'clock in the morning, and die down again toward evening. The dead leaves, twigs, humus, etc., are all very hygroscopic, and absorb moisture from the atmosphere very rapidly as their temperature falls toward evening. This, together with the decrease of the wind, soon brings the ordinary forest fire under control, and there is little danger of a fresh outbreak until the following day.

FIRE LINES.

When a forest fire, with a good start, is running before a strong wind, it is usually impossible to do any very effective work in front of it, and attention should be given to fire lines along the sides to prevent its spread laterally, as the wind may change at any time and drive the fire in another direction. This is especially imperative if valuable property should be threatened by such a change of wind. As soon as the fire can be checked in the evening, every effort must be made to complete the fire line around the area before 10 o'clock the next morning.

The character of the fire line to be made around a burning area depends on the character of the fire. If it is a light surface fire running over a moist soil, it is sufficient simply to remove all inflammable material from the surface of the ground in a strip 3 to 6 feet wide. If, however, the soil itself is dry, as is often the case, a trench must also be dug through the organic soil or duff. The soil removed should be thrown on the side of the trench toward the fire.

After the fire is under control the fire lines should be patrolled night and day until absolute safety is assured, or until rain falls. This is of the first importance, in order to make sure that no fire gets across the fire line. A fire may smolder away for days and even weeks after it is pronounced out, only to break out with as great fury as ever on some especially favorable day. Even a fairly heavy rain may not entirely extinguish a duff fire.

Care should be taken to fell burning stubs after the fire is under

control. These can best be seen at night, and are particularly dangerous because of the distances to which they may throw their sparks.

The number of men required to handle a fire is the number needed to prepare an efficient fire line around the area, and this will necessarily vary in nearly every case. In the organization of the force it is rarely possible for one boss to handle more than ten men satisfactorily, and on night work the number should be reduced to five. The ax, hoe, and shovel are the tools which must be relied upon for fire fighting under most circumstances. Occasionally it is possible to use a plow in making a fire line, and it should be used whenever practicable because of the great saving in time and labor. Pails should always be available, and may, when near a water supply, be used to great advantage.

BACK FIRING.

As a means of combating a running fire, back firing is rarely practicable, and when the wind is very high it may be entirely out of the question. However, if a road, good trail, or brook be available as a fire line, with plenty of men to prevent the back fire itself from getting across the line, it may be possible to do something. Usually its use is limited to checking the spreading of a fire laterally from the direction of the wind, and in the protection of valuable property at the sides of the fire. In any case the first essential is a good fire line, and the next a sufficient force of men to keep the fire on the right side of the line. Indiscriminate attempts at back firing can only increase the destruction.

The prompt payment of the men employed in fire fighting and patrol is of prime importance. The lack of it always has been and still is one of the most serious drawbacks to efficient fire protection in several of the States which have otherwise well-organized systems. The time required to close the accounts varies in different States from several months to more than a year. Such delays in payments make it difficult to get together a force of men to fight fires, even if the pay is high.

FOREST INDUSTRIES.

LUMBERING IN NEW HAMPSHIRE.

From the first settlement of the region lumbering has been a leading industry. There was always a demand for building material and ship timber from the towns along the coast. The first settlements were in the broad valleys of the main rivers—the Connecticut, the Saco, and the Androscoggin. The forest was looked on as more or less of an obstruction to agriculture, but the immense veteran white pines were always recognized as valuable. Extracts from the history of the early settlements are of interest. That of the settlement of Shelburne, on the Androscoggin, in 1800, records:

> For some years clearing land and raising food was the principal industry. The largest and straightest trees were reserved for the frames of the new houses;

shingles were rived from the clearest pine; baskets, chair bottoms, cattle bows, etc., were made from brown ash butts; all the rest of the timber cleared was piled and burned on the spot. Logging was always a standard industry, and the timber holds out like the widow's meal and oil. All the pines went first; nothing else was fit for building purposes in those days; tables were made 2½ feet wide from single boards without knot or blemish.

In a memoir by Lucy Crawford on the early settlement of Conway, in the latter part of the eighteenth century, we read:

They soon began the lumbering business by floating logs and masts down the Saco to its mouth, where they received breadstuff and other necessaries of life in exchange.

By 1852 the lumber industry had become well established. A gazette of that year records:

In the town of Berlin there are three large sawmills, two furnishing employment to 50 to 60 men, and a third for about 40. There are several others employing 5 to 10.

And further on it says:

In the town of Errol several big streams unite with the Androscoggin, and upon this stream have been expended quite recently more than $100,000 in erecting dams, etc., for the purpose of holding back the water so as to enable the companies engaged in the enterprise to drive logs from the upper lakes to market through the whole season.

These extracts give an indication of the growth of the lumber industry. The present lumbering in the region can best be described under three heads: (1) In the southern townships, where the cutting is all of so-called second growth; (2) in the White Mountain region proper, where there are still considerable areas of uncut land; (3) in the north country, where there are vast stretches of lightly culled and virgin forest.

LOGGING IN THE SOUTHERN TOWNSHIPS.

The lumbering here has adapted itself to the change in forest conditions. There are no extensive tracts of unculled timber which would keep a large mill running. Numerous small mills scattered over the country cut the second growth as it becomes merchantable. The manufactured product is very varied; everything is made, from rough boards to excelsior, from flooring to handles and bobbins. Every kind of timber is utilized, the largest percentage being of second-growth white pine and spruce for boards and dimension stuff. The hardwoods are used for flooring, cordwood, bobbins, shoe pegs, etc.

There are many small water-power mills which do custom sawing for farmers in the vicinity. There are also portable mills, which are moved into the tracts of second growth and cut it into boards on the spot. There are also many small stationary steam mills which get sufficient stumpage from the surrounding woodlots for a continuous supply. The lumbering in this region is on a small scale, but also on a permanent intensive basis.

Where companies own their own timberland, the cutting is usually conservative and careful, but when buying stumpage they usually cut as clean as is profitable and pay no attention to injury of young growth. The character of the cutting also greatly depends upon whether the mill is portable or stationary. The portable mills are transported right into the midst of a 50 or 100 acre woodlot, so there is only the cost of cutting and yarding, and no long haul. Hence it is profitable to cut everything which can be converted into a board, and the cutting is accordingly clean.

Stationary water-power mills, which do mostly custom sawing for farmers, are most conducive to conservative lumbering. The cost and running expenses of the mill are slight, and it can accordingly be run at irregular intervals when there are logs to be cut. Stationary steam mills are more expensive, and have to do more sawing to realize a proper interest on the capital invested. The policy of these mills, however, is generally to cut conservatively, on their own land at least, so as to obtain the most possible timber in the long run, and a continuous supply.

LOGGING IN THE MOUNTAINS.

Logging in the mountains is all by large companies and on a large scale. The timberlands are owned almost entirely by seven large companies. Three of these concerns cut upward of 75,000,000 board feet a year, mostly virgin timberland. About two-thirds of this goes into lumber, and the other third into pulp. The policy of all the companies is to hold the land after cutting. Most of the large concerns desire to cut conservatively, if possible, or at least to save the young growth for future crops. This policy is, however, seldom carried out in the mountains.

Clean cutting is practiced on all the steeper slopes, and little is left after lumbering. One reason for this is that windfall is very severe, and any trees left standing are almost certain to be wind-thrown. On the lands of one company in particular no thought is given to a second crop; everything on the steep slopes is cut. The logs are rolled down the slope to the road below over the nonmerchantable stuff and the hardwoods, which are felled down the slope and form a good rolling bed. The result is a veritable fire trap that lasts for years. On the more moderate slopes the softwoods are got out without cutting the hardwoods. The policy of this company is to cut all its timber and then move into the west, where it already owns large tracts of forest.

The most conservative cutting in the White Mountains has been done by an operator in Livermore, who cuts simply to supply his own mill. This has an output of only 4,000,000 board feet per year. This operator cuts to a rough diameter limit of 10 inches on the stump, and has been over the same ground twice, having cut the

first time to a limit of 14 inches (Pl. VII, fig. 2). It must be remembered, however, that no pulpwood is cut on this land.

The general policy of one of the paper companies is to cut fairly conservatively, so that the same area may be again cut within thirty to sixty years, but in the absence of careful inspection the policy is not well carried out. Most of the logging is let out to jobbers, who bring the logs to the bank of the stream where they are to be driven or to the railroad. There are stipulations in the contracts between the jobbers and the company in regard to the cutting, but without more stringent inspection they are not fully effective.

LOGGING IN THE NORTH.

In the northern part of the State nearly all the lumbering is carried on by three companies. Upward of 100,000,000 board feet of logs are taken out yearly by these companies, almost exclusively spruce mixed with about 10 per cent balsam. The lumbering here is characterized by long hauls and long drives, the mills being located at a considerable distance from the source of supply. There are no large mills in the region.

One company employs an expert forester to oversee and encourage conservative cutting. His duties are to inspect the various cuttings to determine the amount of unnecessary waste, to look out for diseased and infected timber which should be cut immediately in order not to be a total loss, and to make topographic maps of the company's lands, useful in logging operations.

Another company cuts chiefly for sawlogs, and in consequence considerable young stuff is left on the land after lumbering.

In general, lumbering in the north can be put on a more conservative basis than in the higher mountains, where the slopes are steeper and windfall more severe; but even there much can and should be done to prevent needless waste in logging and exposure of the cut-over lands to fire. No policy of conservative cutting, however, will be satisfactory unless it is wisely conceived and properly carried out.

THE WOOD INDUSTRIES.

The wood-consuming industries in the region considered by this report manufacture paper, and wood-pulp, lumber, bobbins, shoe pegs, crutches, excelsior, spools, rakes, handles, chairs, racket frames, picket sticks, wood shanks, veneer, and ladder rounds.

The paper and wood-pulp, lumber, bobbin, shoe-peg, and crutch industries comprise three or four establishments each. The remaining industries comprise one or two establishments each. They are below described collectively under the head of miscellaneous industries.

The amount of wood consumed by the wood industries, and also

the amount of wood cut in the region, for the year ending June 30, 1903, are shown in the two following tables:

TABLE XXIII.—*Timber cut in northern New Hampshire, July 1, 1902, to June 30, 1903.*

Industry.	Total.	Spruce.	Pine.	Hemlock.	Hardwoods.
	1,000 board feet.	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*
Paper and pulp	105,552	105,552	----	----	----
Lumber	155,570	120,195	17,213	6,679	11,483
Bobbin	6,709	----	----	----	6,709
Shoe peg	3,081	----	----	----	3,081
Crutch	150	----	----	----	150
Miscellaneous	2,500	----	----	----	2,500
Total	273,562	225,747	17,213	6,679	23,923
Per cent	100.0	82.5	6.3	2.4	8.8

TABLE XXIV.—*Wood consumed by mills in northern New Hampshire, July 1, 1902, to June 30, 1903.*

Industry.	Number of establishments.	Total.	Spruce.	Pine.	Hemlock.	Hardwoods.
		1,000 board feet.	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*
Paper and pulp	6	167,070	167,070	----	----	----
Lumber	65	131,635	98,185	16,128	6,334	10,988
Bobbin	9	6,709	----	----	----	6,709
Shoe peg	3	2,731	----	----	----	2,731
Crutch	4	150	----	----	----	150
Miscellaneous	9	2,500	----	----	----	2,500
Total	96	310,795	265,255	16,128	6,334	23,078
Per cent	----	100.0	85.4	5.2	2.0	7.4

A comparison of these two tables shows that the total amount of wood consumed by the mills in this region exceeds the total cut by over 37,000,000 board feet. Moreover, a large part—over 24,000,000 board feet—of the wood cut goes to outside mills; therefore, the actual excess of wood consumed over the amount received from this region is over 61,000,000 board feet and constitutes nearly 20 per cent of the wood consumed in northern New Hampshire. This is explained by the fact that most of the pulp companies are preserving their own supply of timber, preferring to draw upon an outside source, chiefly Canada, and that the demand for wood, especially spruce, is greatly in excess of the supply.

The chief commercial species is spruce, which represents 82.5 per cent of the total cut of all species. Mixed with spruce is balsam to the amount of about 10 per cent. Chief among other conifers are white pine and hemlock. The principal hardwoods are paper and yellow birch and sugar maple. Practically all species find a market in some form of product, as is shown in the table on the following page.

TABLE XXV.—*Uses of the commercial species.*

SPRUCE.

Pulp.
Lumber:
- Dimension.
- Plank.
- Boards.
- Flooring.
- Ceiling.
- Clapboards.
- Shingles.
- Lath.
- Box shooks.
- Piano boards.
- Pump tubing.

BALSAM.

Pulp.
Lumber:
- Plank.
- Boards.
- Flooring.
- Ceiling.
- Shingles.
- Lath.
- Box shooks.

Excelsior.

WHITE PINE.

Lumber:
- Dimension.
- Plank.
- Boards.
- Flooring.
- Ceiling.
- Shingles.
- Lath.
- Box shooks.
- Clapboards.

HEMLOCK.

Lumber:
- Dimension.
- Plank.
- Boards.
- Flooring.
- Ceiling.
- Shingles.
- Lath.
- Box shooks.

Pulp.

PAPER BIRCH.

Lumber:
- Flooring.
- Dimension.

Bobbin stock:
- Bobbins.
- Speeders.
- Quills.

Shoe pegs.
Spools.
Crutches.
Shoe shanks.
Staves.
Veneer.
Rake teeth.
Dowels.
Chair stock.

YELLOW BIRCH.

Lumber:
- Flooring.
- Dimension.

Bobbin stock:
- Bobbins.
- Speeders.
- Quills.

Spools.
Crutches.
Shoe shanks.
Staves.
Veneer.
Dowels.
Chair stock.
Piano backs.

SUGAR MAPLE.

Lumber:
- Dimension.
- Flooring.

Bobbin stock:
- Bobbins.
- Speeders.
- Quills.

Crutches.
Staves.
Dowels.
Chair stock.
Piano backs.
Handles.
Veneer.

BEECH.

Rough lumber.
Bobbin stock:
- Bobbins.
- Speeders.
- Quills.

Chair backs.
Staves.
Piano backs.
Dowels.

POPPLE OR ASPEN.

Excelsior.
Pulp.
Boxes.
Veneer.

WHITE ASH.

Handles.
Picket sticks.
Racket frames.
Rakes.
Staves.
Ladder rounds.

BASSWOOD.

Excelsior.
Boxes.

SILVER BIRCH.

Bobbin stock.
Shoe pegs.
Spools.

RED PINE.

Lumber (together with white pine).

TAMARACK.

Rough lumber.

CEDAR.

Shingles.

RED OAK.

Chair stock.
Ladder rounds.

GRAY BIRCH.

Bobbins.

RED MAPLE.

Veneer.
Chair stock.

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"Silver" birch in the above table is merely a local name for second-growth yellow birch. Its chief value is its minimum amount of heart-wood, which makes it especially desirable for pegwood. Paper birch is known also as white birch.

Stumpage and log values of the commercial species are shown in Table XXVI, which was compiled from figures furnished by the various mills in the several industries. The values were arranged according to the amount of timber of each species consumed by each mill. The values per cord represent the averages of actual prices paid per cord, and were not deduced from the values per 1,000 board feet.

TABLE XXVI.—*Average value of the commercial species.*

Species.	On stump.		Delivered at mill.	
	Per 1,000 board feet.	Per cord.	Per 1,000 board feet.	Per cord.
Spruce	$3.77	.....	$10.18	$6.43
White pine	3.74	.....	8.32	.....
Hemlock	2.90	.....	7.28	.....
Paper birch	2.97	$1.77	10.05	7.46
Yellow birch	2.96	1.68	9.97	6.75
Sugar maple	2.99	1.39	10.06	6.07
Beech	2.90	1.10	8.00	5.95
Popple	.....	1.60	.....	5.13
White ash	10.00	.....	21.57	.....
Cedar	3.00	.....	9.00	.....
Red oak	.....	.....	12.67	.....
Basswood	.....	.....	.....	4.50
Tamarack	.....	.....	9.00	.....
Red maple	.....	.....	8.00	.....

A glance at the figures given for paper and yellow birch and sugar maple in the above table shows a seeming discrepancy in the values per 1,000 board feet and per cord, in that the values per 1,000 board feet for the three species are practically the same, whereas their values per cord differ considerably. The explanation of this is that the lumber industry regards the three species indiscriminately; hence their almost equal values per 1,000 board feet. On the other hand, of those industries which buy by the cord, the pegwood industry has a decided preference for paper birch and "silver" birch, must have selected stock, and so pays for it accordingly. As a matter of fact, the comparative values of these three hardwoods is better shown by the price per cord delivered at the mill.

The data from which the values for beech, popple, ash, cedar, oak, basswood, tamarack, and red maple were computed were decidedly meager, owing to the small amounts of these species used within this region. However, it is believed that their comparative values are fairly well shown by the figures here given.

In 1900 the relative positions of the lumber and paper industries among the various industries in New Hampshire were, respectively,

third and fifth. Cotton and print cloth and boots and shoes were, respectively, first and second, and woolen goods fourth.

THE PAPER AND WOOD-PULP INDUSTRY.

Until about 1870 practically all paper was made from rags. Since then in the making of many grades of paper, especially news paper, wood fibers have been almost completely substituted. The wood fibers are transformed into pulp by two processes—mechanical and chemical. By the mechanical process blocks of wood are held against a revolving stone by means of hydraulic pressure and the fibers ground into a pulp. The product is known as ground wood-pulp. There are two chief chemical processes—the caustic soda and the bisulphite processes. The latter alone concerns this report.

By the "bisulphite" process the wood is cooked in a solution of sulphurous acid and water under conditions of high temperature and pressure. The product is known as sulphite pulp. The grinding process produces a short fiber, whereas the "sulphite" process produces a relatively long fiber, which is practically intact and gives to news paper the essential quality of strength. The latter process also produces fiber of a better quality, because free from resinous matter found in pulp prepared by grinding. Ground wood and sulphite fiber, the latter forming from 15 to 25 per cent of the mixture, produce most of the news paper made in the United States.

The growth of the paper and wood-pulp industry in New Hampshire during the decade between the census years 1890 and 1900 eclipses that made in any other State in the Union. During this period the value of its product has multiplied nearly six times, and the amount of capital invested nearly seven times.

TABLE XXVII.—*The paper and wood-pulp industry in New Hampshire.*

[From Twelfth Census.]

Year.	Number of establishments.	Average number of wage-earners.	Total wages.	Total capital.	Value of product.
1890	15	520	$220,122	$1,221,491	$1,282,022
1900	29	2,391	1,036,856	8,163,081	7,244,733

The nearest approach to this increase of any of the leading pulp-producing States is shown in the census figures for Maine, where in the corresponding decade the capital invested and the value of the product have each multiplied more than four times. In 1890 the relative position of New Hampshire among the States in the value of its product and invested capital was, respectively, thirteenth and fourteenth; in 1900 its position with respect to both product and capital was sixth. The term "establishment" is used as representing a mill

or mills owned by one individual, firm, or corporation when located in the same town.

The advance of New Hampshire to one of the leading States in this industry is attributable to the greatly increased use of wood-pulp in the manufacture of paper, to its large supply of spruce—the preferred wood for pulp—and to its nearness to supply from Canada and Maine. In 1900 the total cost of all materials used in New Hampshire in the manufacture of paper was nearly $4,000,000; of this, less than $300,000 represents the total outlay for rags, waste paper, and manila stock, while over $2,000,000 was paid for wood and wood-pulp. Rags and similar materials play a very small part in the manufacture of paper in the State, and in the region considered by this report absolutely no part whatever.

The following table shows the quantity and cost of the various materials used in the paper industry in New Hampshire in 1900:

TABLE XXVIII.—*Materials used by the paper and pulp mills of New Hampshire in 1900.*

[From Twelfth Census.]

Materials.	Cords.	Tons.	Cost.
Wood:			
Domestic spruce—			
For ground wood	41,035		$242,055
For sulphite fiber	68,006		413,141
Canadian spruce—			
For ground wood	4,089		24,756
For sulphite fiber	83,050		474,578
Other pulpwood, for ground wood	720		3,430
Total	196,900		1,157,960
Rags, including cotton and flax waste and sweepings		2,700	61,573
Old or waste paper		6,327	121,466
Manila stock, including jute, bagging, rope, waste, threads, etc.		2,947	64,684
Total		11,974	247,723
Fiber:			
Ground wood-pulp purchased		21,266	338,316
Soda wood fiber purchased		2,396	95,946
Sulphite wood fiber purchased		12,123	418,680
Other chemical fiber purchased		21	372
Total		35,806	853,314
Chemicals			459,303
Clay			52,902
Colors			24,000
Sizing			11,421
All other stock			36,759
Fuel, rent of power and heat, mill supplies, freight, and all other materials			1,109,952
Total for New Hampshire	196,900	47,780	3,953,334
Total for United States	1,986,310	1,701,319	70,530,236

The county of Coos is the great paper and pulp producing region in the State. In 1900 it had more than 61 per cent of the total capital invested, bought over 65 per cent, in value, of the material used, and yielded, in value, more than 68 per cent of the products. Four of the six establishments in the region examined are in Coos County.

TABLE XXIX.—*Timber cut in New Hampshire for pulp, during the year ending June 30, 1903.*

Source of supply.	Cords.	Board feet.
Northern New Hampshire	172,020	105,552,000
Cut for mills in northern New Hampshire	138,131	84,934,000
Cut for mills elsewhere in New Hampshire and in Vermont	33,889	20,618,000
Outside northern New Hampshire, all cut for mills outside	4,640	3,093,000
Total for New Hampshire	176,660	108,645,000

An important showing of the above table is the comparison possible of the amount of wood cut for pulp in the region considered by this report with that cut in the rest of the State. Of the total for the whole State, 97.4 per cent comes from this region, and of the total for this region, 80.3 per cent is consumed by mills located in it. The estimate in board feet is chiefly for a basis of comparison with the amount of wood consumed by the other industries. In the case of some mills, this estimate was not available and had to be deduced from the estimate per cord. This was accomplished by a converting factor, according to the particular log rule used. The Blodgett (115 cubic feet) and the Bangor rules allow $1\frac{5}{8}$ cords per 1,000 board feet, the Scribner rule, $1\frac{2}{3}$ cords. Obviously, such estimates are only approximately correct, but sufficiently so, nevertheless, for this purpose.

As previously stated, spruce is the chief species used for wood-pulp. Balsam to the amount of 10 per cent is generally allowed, and by some mills a very little hemlock and popple, the aggregate of which is inconsiderably small. Of the total cut of spruce for pulp in northern New Hampshire, balsam forms 9.1 per cent; in the rest of the State, from 1 to 5 per cent. The pulp mills owning timberland or buying stumpage as a rule cut balsam along with spruce; but when buying wood delivered at the mill they want pure spruce, and will rarely accept any balsam. One large paper company which owns perhaps the finest body of timber in the region cuts absolutely no balsam for pulp. Spruce is especially desirable for wood-pulp, owing to its long fiber and freedom from pitch. Some of the chief objections to other species are listed below:

Balsam.—Pitch partially eliminated by the chemical process; not eliminated by the mechanical process, and in consequence "pitches"

the wire screens of the pulp machines; short fiber, making a relatively weaker paper.

Hemlock.—Short, brittle fiber, working poorly on the pulp cylinders by not "sheeting," or holding together well. Discoloration (reddish tinge) partially eliminated by the chemical process. This sometimes causes the pulp to be mistaken for poorly cooked spruce. Knotty; hard to work.

Popple.—Too soft for news paper. Short fiber; lack of strength.

The extent of the manufacture of wood-pulp in the region considered by this report is shown in the two following tables, which give, besides the output for the year ended June 30, 1903, the amount of wood consumed in producing the output, and the sources from which the wood was obtained.

TABLE XXX.—*Output and consumption by pulp mills in northern New Hampshire, July 1, 1902, to June 30, 1903.*

Kind of product.	Number of establishments.	Output.		Wood consumed in producing output.
		Ground wood.	Sulphite fiber.	
		Tons.	*Tons.*	*Cords.*
Ground wood	3	45,175	.....	51,633
Sulphite fiber	4	.....	125,010	219,911
Total	7	45,175	125,010	271,604

It is to the purpose here to make mention of the new pulp and paper mill now being erected at Berlin. The mill is expected to be in operation by June, 1904. Its daily capacity is reported to be 60 tons of sulphite fiber and 125 tons of ground wood-pulp, to produce which will require over 225 cords of wood per day.

TABLE XXXI.—*Wood consumed by pulp mills in northern New Hampshire, July 1, 1902, to June 30, 1903.*

Source of supply.	Cords.	Per cent.
Northern New Hampshire	138,131	50.9
Canada	101,911	37.5
Maine	31,562	11.6
Total	271,604	100.0

According to Table XXX there are apparently seven establishments; but, as a matter of fact, there are only six, since one establishment manufactures both kinds of pulp. From this table can be determined the amount of wood-pulp produced by 1 cord of spruce and balsam (the latter not to exceed 10 per cent of the total), which in ground wood is 1,752 pounds, in sulphite fiber 1,137 pounds.

The interesting feature in Table XXXI is the large amount of wood which comes from Canada—37.5 per cent of the total used in northern New Hampshire. The Twelfth Census reports that of the Canadian wood of all kinds imported for pulp, which forms about one-fifth of the entire supply of wood used for pulp in the United States, New Hampshire and New York together use two-thirds.

During the last three years the increased use of wood for pulp by the pulp mills throughout the State has been enormous. This is shown in the following table, constructed from Tables XXVII, XXVIII, and XXX:

TABLE XXXII.—*Demand for pulpwood in New Hampshire, 1900 and 1903.*

Source of supply.	1900.	1903.
	Cords.	*Cords.*
New Hampshire	109,761	163,035
Canada	87,139	101,911
Maine	.....	31,562
Total	196,900	296,508

The paper mills in northern New Hampshire, included in four establishments, produced during the year ended June 30, 1903, 69,600 tons of paper. These mills use practically all of the ground wood-pulp produced in the region, and a very small part, less than 15 per cent, of the sulphite fiber produced there. The bulk of the sulphite fiber goes to other New England paper mills. During the past year the paper mills in the section examined received a small part of their supply of pulp, amounting to about 15,000 tons, from foreign sources—Maine and Canada.

The chief product of the paper mills is news paper, which finds a market in this country and abroad. A small part of the product includes manila, bag, and wall papers.

The chief waste products are "screenings" and "sulphite liquor." Screenings consist of the unground and uncooked fibers which fail to pass through the screens in the pulp mills. For the most part this waste is used for fuel. Sulphite liquor is the waste liquor from the sulphite process, for which, according to an eminent authority, there has as yet been evolved no satisfactory application. In this region the liquor is neutralized and allowed to run off into near-by streams.

The combined holdings of timberland by pulp and paper mills in northern New Hampshire are 488,290 acres. This acreage includes the great bulk of virgin timberland in the region. The policy of the paper companies, with a single exception, is to log their timber conservatively and hold the land for a second growth. That at times they fully disregard conservative logging can not be denied. This

is, for the most part, determined by the situation of the timber, particularly on high, steep slopes, where danger from windfall precludes the hope of leaving even a fair percentage of the original stand. The owners are thoroughly alive to the importance and farsightedness of a policy of perpetuating their supply of timber, and, as a means to this end, with a view to cutting as little as possible from their own land at present, they are getting a large part of their supply from farmers' woodlots and Canada. This statement with regard to Canada is substantiated by the figures in Table XXXI. An evil of no mean extent, caused indirectly by the paper companies looking for a supply from New Hampshire outside of their own holdings, is the complete and ruthless clearing of small holdings. The farmer is usually the sufferer, who, as a rule poor, will "skin" his land and ship the wood to a pulp mill for any reasonable price.

The question was asked the various pulp-mill owners as to the length of time the present supply of spruce might be expected to last, and also as to the substitution of another species for pulp when the supply should have been exhausted. Their replies certainly indicate that they are not anticipating a spruce famine in the near future, and that they will not worry over a substitute for spruce until the available supply of spruce in Canada is exhausted.

THE LUMBER INDUSTRY.

The relative position of New Hampshire among the various States as to capital invested and value of product in the lumber industry is respectively 19 and 25, according to the census of 1900. The census includes in the lumber industry its various auxiliary industries also, of which those represented in northern New Hampshire, such as the bobbin, the shoe peg, etc., are separately described in this report, chiefly for the purpose of showing the relative amounts of wood consumed by each.

The State is completely overshadowed by the Lake States, and such States as Pennsylvania, California, and Washington. However, it is more intensively lumbered, per acre of wooded area, than any of the above States. The wooded area of New Hampshire in 1900 was estimated at 3,228,000 acres; the total amount of timber cut for lumber was 570,357,000 board feet, or 177 board feet per acre of wooded area. Wisconsin follows with 175 board feet per acre, Pennsylvania with 163, Ohio with 161, and so on down to Texas, with but 15 board feet cut per acre of wooded area. Obviously, these figures show fairly accurately the extent to which the lumber industry is using the forest resources of a State. From these figures, New Hampshire is certainly using hers at a rapid rate, but the important question is, how nearly the annual cut is offset by the growth in the forest and on cut-over land. Unfortunately no data exist for ascertaining this, but the

opinion of many well-informed men in the State is that New Hampshire, as a whole, is producing more timber in yearly growth than is being cut. Their opinion is based, and correctly, upon the very large number of abandoned fields throughout the State which, forty to fifty years ago given entirely to agriculture, are now covered with dense and thrifty stands of timber. It may be well to add, however, that this condition of affairs is not so marked in northern New Hampshire as in the rest of the State.

The value of the lumber product in New Hampshire has multiplied nine times in the last half century, and has nearly doubled in the decade 1890–1900, as shown in the table below. The decrease in the value of product between 1870 and 1880, and the general decline of the industry in this period, may be explained, in part, by the exodus of many Eastern lumbermen to the pineries of the Lake States. An interesting feature of the table is the gradual decrease since 1870 in the number of establishments, which is chiefly due to the concentration of small holdings into a single ownership.

TABLE XXXIII.—*The lumber industry of New Hampshire.*

[From Twelfth Census.]

Year.	Number of establishments.	Capital.	Average number of wage-earners.	Total wages.	Cost of materials used.[a]	Value of products.
1850						$1,099,492
1860						1,208,629
1870	723	$2,428,193	3,398	$725,304	$2,471,427	4,286,142
1880	680	3,745,790	3,104	548,556	2,272,991	3,842,012
1890	570	7,592,167	5,370	1,600,993	2,607,473	5,641,445
1900	553	11,382,114	4,188	1,654,965	4,927,399	9,218,310

[a] In 1890 and 1900, for purposes of comparison, "Cost of materials used" includes wages reported under the heads of "Logging" and "Cost of keep of animals."

The lumber industry in the region under consideration is represented at present by 65 sawmills, as shown below, varying in daily capacity from 3,000 to 140,000 board feet, and in yearly output from 25,000 to 42,000,000 board feet.

TABLE XXXIV.—*Sawmills in northern New Hampshire.*

Mills with annual output of—	
Less than 100,000 board feet	8
100,000 to 500,000 board feet	27
500,000 to 1,000,000 board feet	9
1,000,000 to 5,000,000 board feet	16
5,000,000 to 10,000,000 board feet	3
25,000,000 board feet and over	2
Portable mills	8
Idle mills	7
Mills outside northern New Hampshire, but supplied in part from it	5
Total	85

Coos County contains the greatest number of mills and produces the largest amount of lumber of the three counties in the district. Coos and Grafton contain the largest mills, the average output per mill in each county, for the year ended June 30, 1903, being about two and a half million board feet, while the average in Carroll was about one-half million board feet, as shown in the following table. The mills of Coos cut the greatest amount of spruce and hardwoods; Grafton, hemlock; and Carroll, pine. The total amount of spruce sawed is nearly three times the combined product of all other species. Mixed with spruce is balsam to the amount of about 4 per cent. Practically no mills separate balsam and spruce, the percentage of balsam varying, according to the location of the particular mill, from 1 to 20 per cent. The mills of Coos saw by far the largest percentage of balsam.

TABLE XXXV.—*Output of the sawmills of northern New Hampshire, July 1, 1902, to June 30, 1903.*

County.	Number of establishments.	Output—1,000 board feet.					Number of shingles.
		Total.	Spruce.	White pine.	Hemlock.	Hardwoods.	
Coos	25	67,300	55,300	4,320	1,825	5,855	9,125,000
Grafton	21	52,965	42,220	3,588	3,289	3,868	1,210,000
Carroll	19	11,370	665	8,220	1,220	1,265	2,065,000
Total	65	131,635	98,185	16,128	6,334	10,988	12,400,000

A very small part of the supply of the mills contained in the above table comes from a source outside of this region, as shown below:

TABLE XXXVI.—*Lumber from outside sources sawed in northern New Hampshire.*

Spruce	2,300,000	board feet.
White pine	1,025,000	do.
Hemlock	200,000	do.
Hardwoods	375,000	do.
Total	3,900,000	do.

Practically all the above comes from Vermont and goes to mills in Coos County. A large amount of the timber cut in northern New Hampshire goes to outside mills, as shown below:

TABLE XXXVII.—*Timber cut for lumber in northern New Hampshire.*

Milled.	Per cent.	Total.	Spruce.	White pine.	Hemlock.	Hardwoods.
		1,000 board feet.	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*	*1,000 board feet.*
Within northern New Hampshire	82.1	127,735	95,885	15,103	6,134	10,613
Outside northern New Hampshire	17.9	27,835	24,310	2,110	545	870
Total	100.0	155,570	120,195	17,213	6,679	11,483

Of the 65 mills in this region, 52 manufacture spruce lumber, 40 manufacture pine; 35, hemlock; and 39, hardwoods. Logs are transported to 3 mills by drive, to 8 mills by railroad, and to 54 mills by team.

The bulk of the logs are scaled by the Blodgett or New Hampshire rule, a caliper rule. Fifty-three mills use this rule, six use the Bangor rule, four the Scribner rule, one scales by the stacked cord, and one relies only on the mill survey. Blodgett's is the legal rule of the State. It is based upon a stick of timber 16 inches in diameter and 12 inches in length, which, by the statutes of the State, is made equivalent to 1 cubic foot, 100 cubic feet being equivalent to 1,000 board feet. As a matter of fact, however, 115 cubic feet are allowed per 1,000 board feet, though in large operations this must be specified in the contract. The consensus of opinion is that Blodgett's is a very fair rule—fair alike for buyer and seller; that while the actual amount of lumber sawed from large logs will overrun the scale, that from small logs will fall short of the scale, the one case offsetting the other. For the most part the log constitutes the full length of the tree, taken to 6 inches at the top, and is scaled according to its middle diameter.

Ninety per cent of the mills using spruce manufacture dimension timber, and this is the chief product of the lumber industry. Practically all goes to Boston, where the bulk sold in 1903 at $19 per 1,000 board feet, which includes a freight rate of $2 to $3 per thousand. Hemlock is manufactured chiefly into dimension stuff; pine, mostly second growth, into rough lumber for boxboards; and hardwoods into flooring. Practically all the lumber is air dried. Of the 65 mills, 25, or about 40 per cent, manufacture shingles, chiefly pine, spruce, hemlock, and balsam. Comparatively few mills do any custom sawing, the average charge for which per 1,000 board feet is for softwoods $2.75, for hardwoods $3.25.

With few exceptions, the mills are of an old, unimproved type, exhibiting a general lack of time and labor saving devices. Within the past ten years only five mills have seen fit to install any modern machinery. Thirty-five are operated by steam power; thirty by water power. The length of time each runs varies from one or two months in the spring to the full year. Only seven mills operate during the entire twelve months; more than 50 per cent of the mills less than six months.

A matter of comparatively recent importance, to the White Mountain lumber mills at least, is the utilization of waste products. Formerly what was in excess over that used for fuel by the steam mills was conveyed to a waste pile and burned. Now, however, the greater part of this, which is made up of edgings, trimmings, etc., is sold per cord locally or shipped even as far as Boston. At the mills it brings now $1.50 to $1.75 per cord. One large company which operates

both a lumber and a pulp mill has ceased manufacturing laths, now using the entire barked slab for pulpwood. Sawdust, if used at all, is used chiefly as fuel, but by many of the water mills, which have no way of utilizing it, it is allowed to float down the stream.

Thirty-four mills own timberland, in the aggregate about 380,000 acres, over 259,000 acres of which is included also in the acreage of timberland owned by pulp and paper companies. Of the above 34 mills, 17, or 50 per cent, lumber conservatively. This consists chiefly in cutting under a simple selection system, taking out trees from 8 to 12 inches and over in diameter, except on steep slopes, which are cut clean; for, owing to danger from wind, etc., if enough of the stand is cut to make the operation pay, all might as well be cut. Of these 17 mills, 12 will hold their land indefinitely for future cuttings; 5 will sell after having cut their land so as to leave at least a salable stand. Fortunately for the region, the portable sawmills are in a very small minority. Here, as elsewhere, the average portable mill moves from woodlot to woodlot, making a clean sweep in practically every case. Its proximity to the supply and, in consequence, the relatively low cost of hauling the supply to the mill are the chief factors in making this profitable.

The tax rate on timberlands is generally low, and has practically no bearing upon conservative lumbering.

As for any precaution against fire in the dry season, only 5, or less than 15 per cent, of the 34 mills owning timberland seem to think it worth while. The land of these 5 mills is traversed or skirted by some railroad, which makes every precaution imperative. One of the chief arguments against conservative lumbering is the liability of cut-over land to fire. Lumbermen argue, Why not cut everything now, since it is only a matter of time when fire will run over the land and burn what remains? In not a few cases last spring, when fire ran over thousands of acres in the mountains, this argument was substantiated. On the whole, however, there is a general willingness among timberland owners to stand a reasonable part of the outlay for any efficient fire system by either the State or the town, and a desire to see such a system put in operation.

The demand for softwood sawlogs is far in excess of the supply, the decrease in which is reflected in the general lack of improvement in the sawmills. The greatly diminished supply of large spruce timber is fairly well shown by the decrease in the manufacture of clapboards. This class of lumber is made from 4-foot butts, which must be at least 16 inches in diameter at the small end. In comparatively recent years nearly every mill in the region made clapboards; now only 9 mills of the 65 make them. It is perfectly clear that the increased use of spruce for pulp is influential nowadays in decreasing

the available spruce for lumber. The growing tendency on the part of lumbermen is to sell out their entire land holdings to pulp companies.

THE BOBBIN INDUSTRY.

The bobbin industry in northern New Hampshire is represented by 9 mills, requiring a total of 10,845 cords of wood to produce about 47,000,000 bobbins, speeders, quills, and rolls, all of which are included under the single head of bobbins. The manufactured product is rough bobbins, as distinguished from the final product subsequently turned out by the various finishing mills. There is no mill in the region which produces the finished bobbin. The species used are paper birch, yellow birch, sugar maple, beech, and gray birch.

TABLE XXXVIII.—*The bobbin industry of northern New Hampshire, July 1, 1902, to June 30, 1903.*

Number of establishments	9.
Average period of operation	9 months.
Total output	46,975,000 bobbins.
Wood consumed in producing output	10,845 cords.
Average price per cord, delivered at mill	$6.15.

Of the 10,845 cords consumed in this industry for the year ended June 30, 1903, 700 came from Canada and 500 from Vermont and from New Hampshire outside of the region considered by this report. Of the 9 mills listed, but 2 own timberland, the total acreage of which is estimated at 25,000 acres. In each case it is the intention of the owner to hold the land indefinitely for a second cutting. Cordwood sticks for bobbins must be at least 5 inches, and for some buyers 6 inches, in diameter at the small end, which ordinarily means the removal of trees with a stem not less than 5 or 6 inches at the top.

Paper and yellow birch and sugar maple are used indiscriminately in the manufacture of bobbins. A large amount of beech is run into speeders chiefly, and gray birch is used to a very limited extent, since it is accepted by only one mill. The maximum price paid for bobbin wood during the past year was $8 per cord for extra-quality paper birch logs with a minimum diameter of 9 inches at the top end.

The bulk of bobbin wood is scaled, per cord, in the log by the Fabian caliper rule. This rule is based upon a log 12 feet long with a middle diameter of 12 inches, yielding 12 cubic feet, 128 cubic feet being allowed to the cord. The Blodgett and Bangor rules also are used.

The bulk of the product of these mills goes to a bobbin and shuttle company of Providence, R. I., from which point it is distributed to their various finishing mills.

THE SHOE-PEG INDUSTRY.

But three peg mills are operating within the area included by this report, all located in the southern part of the region. Paper birch and yellow birch are the species used.

TABLE XXXIX.—*The shoe-peg industry of northern New Hampshire, July 1, 1902, to June 30, 1903.*

Number of establishments	3.
Average period of operation	10.5 months.
Total output of pegs	175,300 bushels.
Wood consumed in producing output	3,506 cords.
Average price per cord, delivered at mill	$8.71.

A comparison of the total output and the total number of cords consumed shows that 1 cord will produce on the average 50 bushels of pegs. Of the two species used, paper birch forms at least 85 per cent, from the highest quality of which the best pegs are manufactured. Yellow birch here is the so-called silver birch, or second-growth yellow birch, which contains a minimum amount of heartwood.

Besides the total number of cords given in the above table, as used by the mills of northern New Hampshire, 450 cords go to outside mills, making the total cut of bobbinwood in the region 3,956 cords.

Pegwood is bought by the stacked cord, usually in 4-foot lengths, the following specifications being strictly adhered to:

Must be straight and free from knots, bunches, black streak, and dead wood.

Must be not less than 6 (or in the case of one mill 7) inches in diameter at the smallest place.

Red heart to be not over one-third of the diameter, and in the center of the stick.

Heartwood is entirely discarded, and forms the bulk of the waste. Owing to the nonavailability of pegwood, due rather to the unwillingness of neighboring timberland owners to cut than to the scarcity of the species, it has become necessary for at least two of the mills to suspend operations, in some instances for several months at a time.

The chief market for the product of these mills is Europe, Germany being the principal distributing point.

THE CRUTCH INDUSTRY.

The crutch industry in this region is represented by four mills, all in the township of Rumney. The species used are sugar maple, yellow birch, and paper birch.

TABLE XL.—*The crutch industry of northern New Hampshire, July 1, 1902, to June 30, 1903.*

Number of establishments	4.
Average period of operation	12 months.
Total output of crutches	6,400 dozen pairs.
Wood consumed in producing output	150,000 board feet.
Average price per 1,000 board feet, delivered at mill	$11.97.

The above table shows that 150,000 board feet will produce 6,400 dozen pairs of crutches, which is about 43 dozen pairs to the 1,000 board feet. In addition to the indigenous species used in this industry, two tropical hardwoods, rosewood and lancewood, are used, though to a very limited extent. The best crutches are made from the highest grade of sugar maple.

The crutches manufactured at these mills find a market in all parts of the United States, from the Atlantic to the Pacific. A limited number go to Canada and Germany.

MISCELLANEOUS INDUSTRIES.

These industries include the manufacture of excelsior, spools, rakes, handles, chairs, racket frames, picket stakes, wood shanks, veneer, and ladder rounds. The species used are popple, paper and yellow birch, white ash, sugar and red maple, beech, red oak, balsam, and basswood.

TABLE XLI.—*The miscellaneous industries of northern New Hampshire, July 1, 1902, to June 30, 1903.*

Number of establishments	9.
Average period of operation	10.7 months.
Wood consumed:	
Board feet	483,000.
Cords	2,650.

The stock for excelsior, spools, wood shanks, and veneer is bought by the cord. The total number of cords consumed is 2,650, as shown above, which equals approximately 2,060,000 board feet. This, added to the number of board feet consumed in the manufacture of chairs, rakes, etc., makes a total of about 2,500,000 board feet used by miscellaneous industries, more than 50 per cent of which is manufactured into excelsior.

CONCLUSIONS AND RECOMMENDATIONS.

The study made by the Bureau of Forestry shows conclusively that the forest plays a most important part in northern New Hampshire, and that a definite change in present policy and methods is necessary. Northern New Hampshire contains large areas of land, valueless for other purposes, upon which a forest of some kind will continue to grow even under the most careless methods, but the highest value of these lands can be realized only under conservative forest management.

It is estimated that visitors to the mountains leave annually in New Hampshire approximately $8,000,000, or about one-half of the value of the total annual lumber production of the State. It is true that lumbering does not permanently affect the attractiveness of the

mountain region as a summer resort, since cut-over lands, if protected from fire, soon become almost as attractive to the eye as virgin forest. But the very existence of the region as a summer resort depends directly upon the protection of the forest from fire, which absolutely destroys the beauty of the landscape. Conservative lumbering also will show a decided advantage over present methods in preserving natural forest conditions. The virgin forest still remaining in the White Mountains is practically confined to two localities—one the northern slope of the Presidential Range and the other that of Waterville. Clear cutting of this virgin growth will undoubtedly result in the slackening of the summer trade for a time in these localities, and it would appear to be to the interest of the State that they should be preserved intact, or at least lumbered conservatively.

FOREST FIRES.

At present fires are the greatest danger threatening the forests of New Hampshire and their dependent industries. The fact that the land burned has for the most part been cut over decreases but little the actual damage done. The area burned over in 1903 was 84,255 acres. Legislation for the organization of an adequate fire service and active and faithful work on the ground are absolutely necessary before forest fires in New Hampshire can be stopped.

It is strongly recommended that power be given the governor to appoint a State forester. The State forester should be a professional forester and should act as chief fire warden. The governor should also have power to appoint the necessary district fire wardens. The State forester should receive a suitable annual salary and all actual and necessary living and traveling expenses while in the field. The district fire wardens should receive a monthly salary and all actual and necessary living and traveling expenses while in the field during periods in which there is danger from forest fires, but should hold office throughout the year. It should be the duty of the State forester to divide into districts that portion of the State in need of protection from forest fires, and to recommend for appointment by the governor a district fire warden to take charge of each district and the removal of district fire wardens not satisfactorily fulfilling their duties. During seasons of danger the State forester should inspect the work of the district fire wardens on the ground. He should prepare and furnish to the district fire wardens fire notices to be posted along all roads and trails in the forest. He should receive power to designate areas upon which, between April 15 and June 10, camping or fishing would not be permitted without a written permit from the district fire warden. He should approve for payment all accounts for salary, expenses, and the employment of labor rendered by district fire wardens.

The district wardens should report to the State forester, should have the power to arrest without warrant for violation of the law, and should be authorized to call out for fire patrol or fire fighting any able-bodied male resident of the district in which fire occurs or which is threatened by fire. The district wardens should issue permits for the burning of brush, prohibited except under permits, and for camping or fishing on wild land between April 15 and June 10, and, subject to the approval of the forester, should organize fire patrols whenever necessary within their districts. They should see that their districts are properly provided with fire notices, and should secure evidence in case of fire. It should be their duty to see that fires are actually prevented, not merely to report them, and their retention in office should be determined by their efficiency in accomplishing this. Men employed to patrol a district or fight fire should be paid by the hour. Delay in making these payments should be carefully avoided.

CONSERVATIVE LUMBERING.

There are approximately 1,684,000 acres of forest land in the region examined, of which only 200,000 are virgin forest. The northern half of the State contains about 4,760,000,000 feet, board measure, of softwoods. The lumbering now going on in northern New Hampshire is chiefly by large pulp and lumber companies who intend to hold their lands for a second crop. To this end, both a definite forest policy and the application of conservative methods in lumbering are necessary. The employment of trained foresters by these large companies is highly desirable. They should make the study on the ground necessary to determine the best methods of conservative lumbering, and they should put those methods into effect. It should be clearly understood that no general instructions can be given which will cover the varying forest problems. The details must be worked out on the ground. The principal sources of waste at present are in cutting high stumps, in leaving good lumber in the tops, in leaving logs and lodged trees in the woods, in the failure to utilize windthrown and dead timber which is still merchantable, in leaving standing merchantable trees which are sure to be wind-thrown, in the failure to leave seed trees in favorable localities, and in lack of protection of young growth in logging operations.

SECOND GROWTH.

A considerable area of the State is occupied by farm woodlots. Many small mill owners draw their timber from second-growth woodlots, and there is a growing movement on the part of lumbermen toward the purchase of tracts of second growth. These woodlots offer for the most part an excellent opportunity for the practice of

forestry with profit. A thrifty woodlot is a most valuable adjunct to the farm. The labor required to keep it in good condition involves no further outlay than a few days' work each year. The returns in firewood, fence posts, and material for other uses pay many times the cost of growing it.

FOREST PLANTING.

Forest planting upon wholly denuded lands, or to supplement incomplete natural reproduction, is already profitable in New Hampshire, when land can be protected from fire. The best species for planting are white pine, Norway pine, and Norway spruce. The white and Norway pine are adapted to the sandy soils, the Norway spruce to the loamy soils. The latter is preferable to the red spruce, because it grows more rapidly, makes a larger tree, and yields the same quality of timber. At least 1,200 trees should be planted to the acre, which makes a spacing of about 6 feet each way. The expense of planting, including cost of plants, should not exceed $8 per acre when the plants are grown from seed or purchased at cost.

It is recommended that the State establish and maintain a forest nursery, under the direction of the State forester, and distribute seedlings and forest tree seeds at cost to farmers and others who may desire to plant. By offering encouragement in this way large areas of waste land suitable only for forest can be rendered productive.

A FOREST RESERVE.

Cut-over lands in the mountain region should be acquired for reserve purposes without delay. This is a measure of great importance. Such land can at present be bought for from $1 to $3 per acre, and its value under efficient fire protection will increase rapidly. Its purchase is a better business venture than that of virgin timberland under present prices, in view of the possibility under public ownership of waiting a comparative long time for returns.

A STATE FORESTER.

As recommended, the State chief fire warden should be a trained forester. It should be his duty to establish and maintain a State forest nursery for the distribution, at cost, of plants and seeds to farmers and lumbermen, to assist landowners in forest planting and in the conservative management of their forest lands, to lecture at public meetings, and to publish and circulate information regarding State forest lands and forest problems.

SHRUBS AND SMALL TREES OF NORTHERN NEW HAMPSHIRE.

Striped maple	*Acer pennsylvanicum.*
Mountain maple	*Acer spicatum.*
Speckled alder	*Alnus incana.*
Mountain alder	*Alnus alnobetula.*
Juneberry (serviceberry)	*Amelanchier canadensis.*
Shadbush	*Amelanchier botryapium.*
Oblong-fruited juneberry	*Amelanchier oligocarpa.*
Red chokeberry	*Aronia arbutifolia.*
Black chokeberry	*Aronia nigra.*
Swamp pink	*Azalea viscosa.*
Scrub birch	*Betula grandulosa.*
Scrub paper birch	*Betula papyrifera minor.*
Moss plant (Alpine)	*Cassiope hypnoides.*
Alpine azalea	*Chamæcistus procumbens.*
Leather-leaf	*Chamædaphne calyculata.*
Creeping snowberry	*Chiogenes hispidula.*
Sweet fern	*Comptonia peregrina.*
Round-leafed dogwood (kinnikinnik)	*Cornus circinata.*
Silky cornel	*Cornus amomum.*
Red-osier dogwood	*Cornus stolonifera.*
Blue dogwood	*Cornus alternifolia.*
Scarlet haw	*Crataegus coccinea.*
Diapensia (Alpine)	*Diapensia lapponica.*
Bush honeysuckle	*Diervilla diervilla.*
Creeping wintergreen	*Gaultheria procumbens.*
Witch-hazel	*Hamamelis virginiana.*
Common or dwarf juniper	*Juniperus communis.*
Swamp laurel	*Kalmia glauca.*
Sheep laurel	*Kalmia angustifolia.*
Labrador tea	*Ledum groenlandicum.*
American fly honeysuckle	*Lonicera ciliata.*
Sweet gale	*Myrica gale.*
Wild holly	*Nemopanthes fascicularis.*
Ironwood (hornbeam)	*Ostrya virginiana.*
Mountain heath	*Phyllodoce carulea.*
Choke cherry	*Prunus virginiana.*
Mountain ash	*Pyrus americana.*
Scrub oak (barren oak)	*Quercus nana.*
Lapland rose bay	*Rhododendron lapponicum.*
Rhodora	*Rhodora canadensis.*
Staghorn sumach	*Rhus hirta.*
Dwarf sumach	*Rhus copallina.*
Poison sumach	*Rhus vernix.*
Fetid currant	*Ribes prostratum.*
Swamp gooseberry	*Ribes lacustre.*
Northern gooseberry	*Ribes oxyacanthoides.*
Sweetbrier	*Rosa rubiginosa.*
Northeastern rose	*Rosa nitida.*
Flowering raspberry	*Rubus odoratus.*
Dwarf raspberry	*Rubus triflorus.*
Red raspberry	*Rubus strigosus.*

High-bush blackberry	*Rubus villosus.*
Millspaugh's blackberry	*Rubus millspaughii.*
Swamp blackberry	*Rubus hispidus.*
Bebb's willow	*Salix bebbiana.*
Crack willow	*Salix fragilis.*
Silver willow	*Salix argyrocarpa.*
Balsam willow	*Salix balsamifera.*
Shining willow	*Salix lucida.*
Bearberry willow	*Salix uva-ursi.*
Tea-leaved willow	*Salix phylicifolia.*
American elder	*Sambucus canadensis.*
Red-berried elder	*Sambucus pubens.*
Meadowsweet	*Spiræa salicifolia.*
Steeple bush	*Spiræa tomentosa.*
Ground hemlock	*Taxus minor.*
Dwarf blueberry	*Vaccinium pennsylvanicum angustifolium.*
Canada blueberry	*Vaccinium canadense.*
Low blueberry	*Vaccinium vacillans.*
Dwarf bilberry	*Vaccinium cæspitosum.*
Great bilberry	*Vaccinium uliginosum.*
Mountain cranberry	*Vaccinium vitis-idæa.*
Hobblebush	*Viburnum alnifolium.*
Withe-rod	*Viburnum cassinoides.*
Maple-leafed arrow-wood	*Viburnum acerifolium.*
Few-flowered cranberry tree	*Viburnum pauciflorum.*
Northern fox grape	*Vitis labrusca.*
Riverside grape	*Vitis vulpina.*
Summer grape	*Vitis æstivalis.*
Privet andromeda	*Xolisma ligustrina.*

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